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GREAT BRITAIN AND IRELAND

BY

ALBERT WILMORE, D.Sc. (LOND.)

F.G.S., F.R.G.S.

AUTHOR OF "THE GROUNDWORK OF MODERN GEOGRAPHY," ETC.

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PREFACE TO REVISED EDITION

THIS book is intended primarily for students of about fourteen to sixteen years of age in the middle and upper forms of secondary schools, and in the higher forms of central schools. The author has incorporated the experience gained over a long period of years as a teacher of geography, and also as an examiner in the same subject for school certificate and matriculation. In the papers set for these examinations considerable emphasis is laid upon a knowledge of the home country. But, quite apart from any question of examinations, it is obviously desirable that every British boy and girl should have a detailed acquaintance with the geography of the British Isles.

The book has now been thoroughly revised and the statistics brought up to date. When it was written in 1921 and 1922 the air was still full of comparisons between pre-war and early post-war conditions. It is assumed that the Homeland has now settled down to normal development.

If the book is to prove of the greatest use students should do much of the work themselves, looking to their class teacher as a guide. The large and varied collection of exercises at the end of the book will be found of great help in this individual study.

A. W.

NOTE

In the latest edition the opportunity has been taken to incorporate the latest available statistics. A few other corrections have also been made.

August 1935.

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GREAT BRITAIN AND IRELAND

CHAPTER I

INTRODUCTORY

THE keynote of British geography is variety. Under a varied surface of hill and dale, plateau and plain, there are found rocks of almost every known type and of every geological age. These rocks occur in nearly every possible way; here they lie horizontally and appear little disturbed, there they are upturned and folded in the most striking manner. The varied action of wind, rain, frost, rivers, glaciers, and sea, at work through long ages, has consequently produced different types of country, and thus there are regions in Britain in which the scenery, the agriculture, the mineral wealth, and the density of population are quite distinct.

This is not only true of the surface features, the underlying rocks, and the character of the coast, but it is true to a less degree of the climate. In some parts of the Highlands of Scotland, the heart of the English Lake District, and the hills of Snowdonia, there is an annual rainfall of 100 inches or more; in parts of East Anglia the total rain amounts to 20 inches per year, or one-fifth of that in the hilly regions mentioned. In the far west of Ireland the difference between the average temperatures of January and July is only 14°; the range in Essex is about twice this amount.

The British Isles lie opposite a most interesting part of the Continent of Europe. The three great races—Mediterranean,

Alpine, and Nordic—which inhabit most of the Continent, converge towards the west. The dividing-line between the Romance and Teutonic languages also comes out to the narrow seas opposite Britain. The British Isles have received, at different times in their history, accessions from the different races, sometimes by invasion, often by peaceful immigration. The people of Britain are therefore a varied "race," and their language is composite in character.

Britain will therefore repay a somewhat careful study, and such a review is here attempted, always understanding Geography as relating to Man, and the earth's surface as his home. Before passing to the more formal study, we shall discuss a few examples of the problems presented and of the way in which such problems may be dealt with.

East Anglia and the Scottish Highlands—A Study in Contrasts

The passenger by train from **Cromer** to **London** rides for a hundred miles across a region absolutely without hills. (See fig. 1.) From the carriage window he may look out over flat or very gently rolling country, given over to wheat or barley or under root-crops; or grass-land with scattered trees—the "Park Land" of the old English country seats. From "Poppy Land," in North Norfolk, across the land of the famous Broads, across Suffolk, with its wide estuaries, and across Essex as he approaches London, wherever the railway passes through a cutting, no hard rock is seen. Under a thick coating of very fertile deposits of quite recent formation there may be seen sands, gravels, and clays, which are easily worked by the plough. The region is the driest in Britain, the rain-gauge telling of a rainfall little more than 20 inches per annum. This low rainfall means that cloudiness is low, or in other words, the amount of sunshine is comparatively high. Hence the success of the crops mentioned above.

Now observe the **Highlands** as seen on a railway journey from **Perth** to **Inverness,** through the famous Pass of Killiecrankie and across the Grampians. (See fig. 2.) The railway track curves among wild mountains and narrow valleys. Rock-cuttings occur frequently, and the train passes over

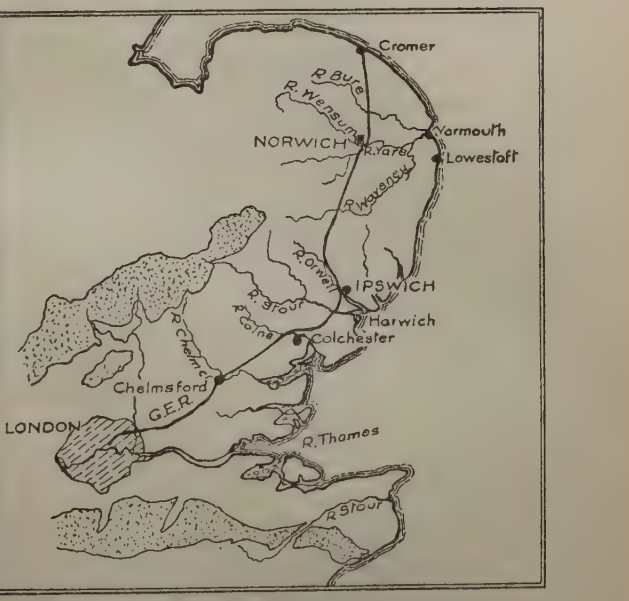


FIG. 1.—EAST ANGLIA.

Showing the route of the former Great Eastern Railway from Cromer to London (134 miles). Land over 300 feet is shown by stippling.

roaring torrents and through deep, lonely glens. Rocky crags crown the hills where the wild deer and the eagle still find a home within sound of the train. Population is very scanty and villages are few, and there are no towns of any size on the route. Instead of wheat-fields and acres of cultivated land, there is the rocky hillside, or the broad, barren moor, where heather, bracken, and coarse grass grow among the stones. In this region there is an annual rainfall of 60 to 80 inches.

The **East Anglian** is mostly engaged in **agriculture**; he grows wheat or barley, potatoes, turnips, peas and beans, and fruit. He works in the large market-garden which supplies London and its suburbs with fresh vegetables every day. He

FIG. 2.—THE GRAMPIAN HIGHLANDS OF SCOTLAND.
Showing the railway route between Perth and Inverness. Land over 1200 feet is shown by stippling. A few lakes are shown.

keeps cattle to supply the big city with milk and butter. The **Highlander** is a **shepherd**; or he looks after shooting rights and acts as a water-bailiff and "watches" the river and the fishing; but occupations are limited and many of the young Highlanders have to go out to the industrial regions to earn a livelihood.

The cause of all these differences has been hinted at already.

It lies first of all in the nature of the rocks. The Highland hills and glens are carved out of very hard, old rocks, which are generally very much crumpled. The soil is thin and poor compared with the thick rich soil of East Anglia. In addition to this there are the climatic differences already mentioned. East Anglia is not much warmer on the whole than the Highlands; to suppose that it is so would be to make a common mistake. But the amount of bright sunshine is greater in East Anglia than in most parts of Britain, and this counts much in its agriculture. Here is consequently the best wheat land; for though the East Anglian winter is somewhat cold, yet wheat can stand it, and if this crop may have a dry, fairly warm summer and plenty of sunshine, it will ripen and repay the farmer. The sugar beet too, a root crop of increasing importance for the supply of cheap sugar finds suitable soil and climate in East Anglia.

'The Highland Liné'—A Study of Mountains & Plain

Readers of Sir Walter Scott's *Rob Roy* will remember that Bailie Nicol Jarvie, the Glasgow merchant, had considerable hesitation in crossing the " line " that separates the **Highlands** from the **Scottish Lowlands.** He considered the Highlands as a region apart, and when, after his adventures within the Highland fringe, he was once more back at Glasgow in his own Lowlands, he vowed that never again would he cross the famous " line." This was in 1715, the year of the first Jacobite Rising. Conditions are, of course, very different now, and no longer are the Highlanders so much a people apart; but there is still the structural " line," the real division, operating in a different way, but of great importance even to-day. (See fig. 3.)

Strathmore—*the Great Plain*—stretches across country from S.W. to N.E. on the very edge of the Highland boundary. This plain is one of the most fertile parts of Britain, and its farms and orchards are well known for their excellent crops.

Now let the observer take his stand anywhere on the fertile lands of the plain and look north-westward. He will see a wall of rugged mountains rising in front of him and stretching

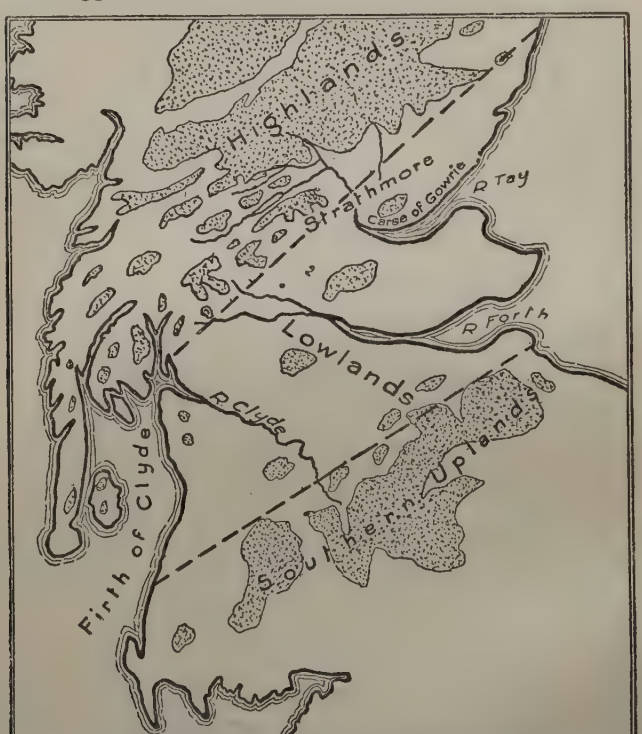


FIG. 3.—NATURAL BOUNDARIES BETWEEN THE HIGHLANDS, LOWLANDS, AND SOUTHERN UPLANDS OF SCOTLAND.

away to S.W. and N.E. These are the **Highlands**, with their deep glens and passes, and rugged, rocky hillsides, and between the plain and the Highlands is the sharp boundary line—a long fault or fracture stretching from sea to sea.

After the Rising of 1715 the Government made the Highland glens more accessible, for General Wade, commencing in 1725,

planned a series of excellent roads right into the heart of the Highland country. This action helped to break down the distrust which existed between the people of the Highlands and the Lowlands, to lessen the differences in race and

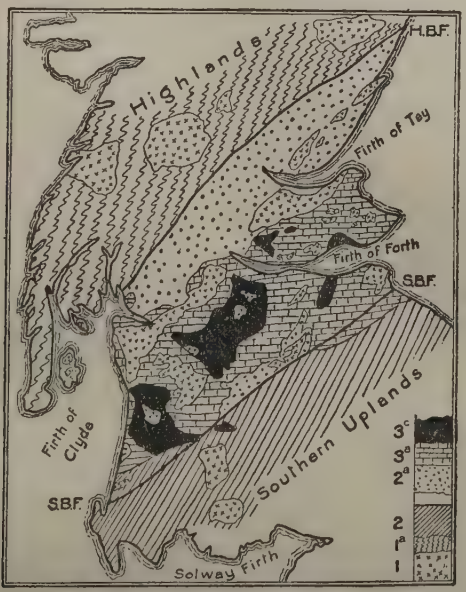


FIG. 4.—GEOLOGICAL MAP OF MID-SCOTLAND.

Key.—1. Granite and other igneous rocks. 1a. Pre-Cambrian and Metamorphic Rocks. 2. Lower Palæozoic Rocks. 2a. Old Red Sandstone. 3a. Carboniferous Limestone. 3c. Coal-bearing Rocks. H.B.F., Highland Boundary Fault. S.B.F., Southern Uplands Boundary Fault.

language, and to bring the Highlands more closely into touch with the rest of Britain. This process has been continued by other roads made in more recent times; and the penetration of the glens by the former North British, the Caledonian, and the Highland Railways has completed the work.[1]

From our first study, we can easily understand that to explain the great difference between the Highlands and the Lowlands

[1] These railways are now parts of the L.M.S. and L.N.E.R. systems.

we must look below the surface again. As already seen, the Highlands are built of hard igneous and much altered rocks; the Lowlands overlie newer and softer rocks. Underneath the fertile subsoil of Strathmore are the rocks of the **Old Red Sandstone** system; the fertile lands of the **Lothians** have the **Carboniferous Limestone** beneath a thick coating of recent deposits. These newer and softer rocks of the Lowlands are sharply separated from the older and harder rocks of the Highlands by the great **Highland Boundary Fault** which runs from the Isle of Arran to Stonehaven. (See fig. 4.)

As we shall see in a later chapter, the Highlands condense much moisture from the prevalent winds from the Atlantic, and these winds then pass over the eastern lowlands. The plains are therefore drier, and this, added to the greater natural fertility of the soil, explains the successful cultivation of oats, root-crops, and potatoes, and the famous raspberries, strawberries, and plums of **Strathmore** and the **Carse of Gowrie.**

A Journey from London to the Midlands

This journey could be made by any one of the following railway routes:—the London, Midland, and Scottish Rly. by Watford and Bletchley to Rugby; the London and North-Eastern Rly. by Aylesbury and Rugby to Leicester; the Great Western Rly. by High Wycombe to Leamington. Or it might be made just as profitably by cycle or motor on the Watling Street through Luton, Dunstable, Towcester, and Daventry to Coventry; or by the trunk road through Watford, Aylesbury, and Banbury to Evesham or Stratford-on-Avon. The general character of the route is the same in all cases. First there is the rise out of London to the suburban fringe, followed by a run of some miles across comparatively level country on which rise a series of low hills such as Harrow, Stanmore, and Mill Hill. At from fifteen to twenty miles from London begins a long gradual ascent up the **Chiltern** slopes, the highest points being

reached near Dunstable, Tring, Wendover, and High Wycombe. Then comes a plain—the fertile **Vale of Aylesbury**; Bedford, Fenny Stratford and Bletchley, Aylesbury and Bicester are towns in this vale. Beyond this again is more climbing, over the hills which are known as the **Northampton Heights** in one part, and as the **Cotswolds** in Oxfordshire and Gloucestershire, where they reach a somewhat greater elevation.[1]

FIG. 5.—THE TWO PARALLEL ESCARPMENTS WITH THE CLAY VALE BETWEEN.

Land over 300 feet is stippled; over 600 feet more closely stippled.

What is the explanation of these successive hills and vales, succeeding each other so regularly in the Midlands? The answer is to be found in the nature and position of the rocks. In the immediate neighbourhood of London are sands, gravels, and clays, among them a great thickness of the well-known **London Clay** which has been of such great importance to London in many ways. These softer rocks are left behind at Aldenham, Watford, and Rickmansworth. Then comes

[1] On Cleve Common, near Cheltenham, the Cotswolds rise to 1070 feet.

Chalk, harder and more resistant, rising into the Chiltern Hills (See fig. 5.) This would be seen in quarries or cuttings at St Albans, Luton, Dunstable; Boxmoor, Berkhampstead, Tring; Amersham, High Wycombe, Princes Risborough. These chalk hills, the Chilterns, rise into fairly high "downs" at Dunstable, Tring, and Princes Risborough.

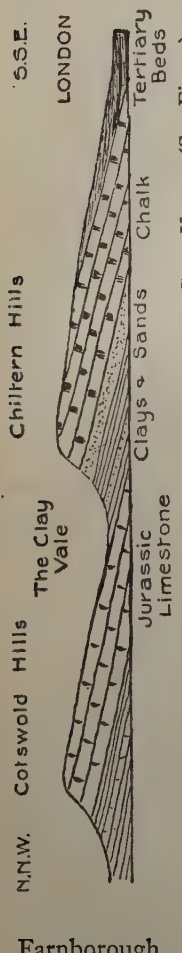


FIG. 6.—SECTION THROUGH THE ESCARPMENTS AND THE CLAY VALE. (See Fig. 5.)

After these chalk hills comes the vale of soft sands and clays, in which the Great Ouse and the Thame meander in their courses. The clays are known as the **Gault Clay,** the **Kimeridge Clay,** and the **Oxford Clay;** and the vale or plain formed by them extends across middle England from Oxford to Cambridge and the **Fenlands.** This Vale of Aylesbury is one of the most fertile regions of Britain, the heavy clay having been mixed in the course of ages with sand and chalky debris washed into the plain from the neighbouring uplands. (See fig. 5.)

Beyond this vale rise the low hills of **Jurassic Limestone,** the north-western faces of which overlook the Avon and Soar lowlands. The London and North-Western Railway cutting at Roade and the tunnel at Weedon are both due to this line of heights. The Great Western Railway from Haddenham through Banbury follows a similar route. The long, gentle railway climb from Brackley to Farnborough, or the cyclist's climb from Banbury to Byfield, are typical examples of how these uplands are dealt with. After these low hills comes the **Midland Plain,**

in which are Leicester, Lutterworth, Rugby, Stratford-on-Avon, and Leamington.

It is clear that the nature of the rocks is the first factor in producing this succession of uplands and lowlands, the uplands resulting from the harder and more resistant beds, the lowlands being occupied by the softer strata. The tilt or " dip " of the beds must also be taken into account. They all dip gently toward the south-east, so that the more resistant Chalk does not actually rise any higher than the Jurassic Limestone of the Cotswolds, though the Chalk is higher in the geological series. A diagrammatic section should make the position quite clear. (See fig. 6.)

East Lancashire—Two Hundred Years Ago and To-day

The next study illustrates the intimate connection between History and Geography. To-day East Lancashire is one of the world's greatest industrial regions. Consider the region bounded by the Ribble on the North, the county boundary of Lancashire on the East, the Mersey on the South, and a line drawn from Warrington to Preston on the West. In this area there is little that is naturally fertile, and much barren moorland. Yet it contains a population of about $3\frac{1}{4}$ millions, and includes the city of Manchester, the " Royal Borough " (now a city) of Salford, eight other county boroughs, and fifteen non-county boroughs.

Two hundred years ago it was one of the comparatively wild, desolate regions of the world. Population was sparsely scattered, good roads were scarce, and how the district was regarded may be understood from some of Macaulay's descriptions of the wilder regions of the North.[1]

What is the cause of the remarkable change ? The answer is to be found in the **Industrial Revolution,** which caused the "centre of activity" of England to shift from the South and

[1] See Macaulay's *History of England*, chap. iii.

East to the North and West. The extended use of coal, the discovery that iron can be smelted by coal and coke as readily as by charcoal, the coming of the steam-engine, the inventions and discoveries in connection with spinning and weaving in the eighteenth century; all these and other causes have led to the great increase of population of East Lancashire and to the enormous wealth produced there. The fundamental causes are—abundant coal, plenty of shale and sandstone, a moist climate and abundant water; and there may be added to these the keen industry and the determination of the people.

The Canals of England—Their Rise and Decline

The first modern English canal to overcome great obstacles was made in 1759–60, by **James Brindley,** and its object was to connect the coal-pits at Worsley with Manchester. This was in the early days of the Industrial Revolution; after that time canal construction proceeded with great rapidity. A complete connecting network was made across the Midland counties in such a way that the Mersey, the Trent, the Severn, and the Thames were all linked up, and barge traffic was possible from any one of these rivers to any other. Thus the four gateways of middle England—N.E., N.W., S.E., S.W.—were all open to such traffic. Canals were even made to cross the Pennine obstacle and so join the industrial region of East Lancashire to that of the West Riding of Yorkshire. The **Leeds and Liverpool** Canal (completed early in the 19th century) was carried through the Craven Gap and so crossed the moorlands with the minimum of lock-construction and tunnelling; its greatest height at Foulridge is 520 feet. The **Rochdale and Huddersfield** Canals cross the Pennines farther to the south, where there is no "gap" so low as that used by the Leeds and Liverpool Canal. The narrow Huddersfield Canal uses the Standedge Tunnel near Huddersfield, which is over three

miles in length. The Rochdale Canal climbs the Pennines by means of ninety-two locks, the highest point between Littleborough and Todmorden being 600 feet.

The era of canal construction lasted until the beginning of that of the railway, and during that seventy years no less than 3000 miles of canals were constructed. With the coming of railways, canal construction practically ceased, and their use and popularity soon declined. Many of them were purchased by the railway companies, and now about one-third of the English canals are in the hands of these companies.

The student of Geography will notice that the chief canals connected important industrial regions, such as the West Riding of Yorkshire with East and South Lancashire, or the Mersey with the Birmingham district. Probably the busiest of all the " barge " canals of Britain is the **Birmingham** Canal ; this fact is clearly connected with Birmingham's central position in the Midlands, and with the fact that several busy industrial regions can be reached without crossing any very high land. (See fig. 59, p. 193.)

The Use of Geographical Principles.—From the above examples of geographical problems the reader will see something of the way in which difficulties may be attacked, and peculiarities explained. He should always note what kinds of rocks are found in the region he is studying—not only the rock-character itself, but the mode of occurrence of the rocks must also be taken into account. The rocks found in the different structural or physical regions will be indicated in the study of these regions in later chapters.

The contents of the rocks are also important, especially those contents—either widespread or rare—which are of economic importance. Rocks and rock-contents of such first-rate importance as **coal** and **salt** need little mention at this point ; their value is too obvious. It is, however, of importance to note also whether they occur near each other. Again, it may be mentioned that the point of view changes

from time to time, with new discoveries and new processes. This is very well illustrated by the rocks of Cleveland, Lincolnshire, Northamptonshire, and Oxfordshire, which contain large quantities of **iron-ore.** Until 1879 or 1880 many of these ores were unworkable because they contain so much phosphorus, an objectionable impurity very difficult to get rid of. In 1879 Thomas and Gilchrist introduced a method of smelting which at once brought these neglected ores into the market. Since 1880 both iron-mining and iron-smelting have increased enormously in these Jurassic regions.

Another very important geographical factor is **climate,** including the prevalent winds, rainfall, and temperature. It will be seen later that while the British Isles on the whole have a uniform climate, there are local differences of considerable importance which help to distinguish one region from another.

Nearness to sea, relation to the sea and to neighbouring lands, must also be taken into account, and the study of the British Isles will give ample opportunity of applying these various factors. By weaving into these the vegetation, the animal life, the races of people, and the various human activities, the subject becomes full of interest and is especially a human study. It is on the latter point of view that emphasis will be laid, and throughout the book Geography will be regarded as the study which deals with the earth as the home of Man.

CHAPTER II

THE STRUCTURE OF THE BRITISH ISLES—NATURAL REGIONS

THERE are no high mountains in the British Isles; in this respect Britain contrasts sharply with such island groups as New Zealand and Japan. In the former are the Southern Alps, an Alpine range, some of whose peaks rise to 13,000 feet; in the latter is the splendid volcanic pile of Fujiyama, rising also to 13,000 feet. The highest point in the British Isles is less than 4500 feet above sea-level. In spite of this lack of high mountains, there is ample diversity of structure and of scenery, and the Geographer finds no difficulty in distinguishing different regions, each with its own special features. There are the wild, rugged mountains of the Highlands of Scotland; the somewhat less rugged, beautiful mountains of the Lake District, North Wales, and the South-West of Ireland; the rounded moorlands of the Southern Uplands, the Cheviots, the Pennines, and South Wales; the gently tilted escarpments of the Midlands and South-Eastern England, the rolling park-like plain of the English Midlands; the lake-strewn plain of Central Ireland; and the fenlands of the Wash, the Humber, and Somersetshire. This ample variety of feature enables the Geographer to divide Britain into a number of well-defined physical or structural regions.

The Structural Regions of the British Isles.

The structural divisions of the British Isles are determined, in the first place, by the nature and position of the rocks. This will appear abundantly as we proceed with our study.

But there must also be taken into account the effect of erosion and denudation upon the rocks, and this in turn depends upon the climate, and upon the length of time the rocks have been exposed to the different weathering agents.

Without taking the rocks into consideration, the Geographer would have little difficulty in dividing the British Isles into a number of well-defined regions. His conclusions are, however, strengthened when he discovers that his regions are underlain by different kinds of rocks and that the natural divisions of the Geographer and the Geologist are broadly the same.

The following physical or structural regions may be readily recognised ; they should be studied with the help of a good orographical map :—

Scotland	1. The Highlands. 2. The Midland Valley. 3. The Southern Uplands.
England and Wales	1. The Pennines. 2. The Lake District Hills. 3. The Welsh Uplands and the "Marches." 4. The South-Western Peninsula. 5. The Midland Plain and its extensions. 6. The Scarp-Lands. 7. The Tertiary Basins. 8. The Fenlands.
Ireland	1. The Caledonian North-West. 2. The Volcanic North-East, or Antrim Plateau. 3. The Mourne Mountains and Newry region. 4. The Wicklow Region. 5. The Great Central Plain. 6. The Armorican South and South-West.

SCOTLAND

The Highlands of Scotland.

A clear, well-defined boundary line stretches across Scotland from Stonehaven in the north-east to the Isle of Arran in the south-west. (See fig. 3.) North-west of this line are the **Highlands** sharply separated by the great boundary fault from the neighbouring **Lowlands.** The rocks of the Highlands are chiefly schists and gneisses, with here and there great masses of igneous rocks, chiefly granite and diorite.[1]

The schists and gneisses belong to the Metamorphic class of rocks; they are of great geological age, are very much crumpled, and hard and resistant. The rocks on the south of the faulted boundary line are of Old Red Sandstone and Carboniferous ages and belong to later geological periods.

The **Highlands** have been described as a wild, tumbled sea of mountains, the individual masses being separated from each other by deep and narrow glens. Scott puts into the mouth of Nicol Jarvie the following description :—" These Hielands of ours, as we ca' them, gentlemen, are but a wild kind of warld by themsells, full of heights and howes, woods, caverns, lochs, rivers, and mountains, that it wad tire the very deevil's wings to flee to the tap of them." There is nothing like a " mountain-range " anywhere. Seen from the top of Ben Nevis, or from Ben Lomond looking north, these mountain masses rise in every direction, almost like the waves of a troubled sea.

The whole Highland region may be divided into three parts —the **Western Islands,** the **Northern Highlands,** and the **Grampians.** The Islands are wild and rugged, dissected into irregular fragments which are separated by a storm-tossed sea. The Northern Highlands are separated from the loftier Grampians by the deep, narrow valley, Glenmore, with its

[1] Refer to the Appendix : " Rocks and Rock Systems."

string of deep lochs. In the north-western part of the Northern Highlands are some very old rocks, often rising into grand isolated peaks from a rugged, worn platform.

The Grampians occur in the country between the Glenmore trough, the Highland boundary fault, and the Western and Eastern Seas. This mountain region is a deeply-cut plateau, the " mountains " being parts of the plateau separated more or less by the deep glens, through which rush the wild Highland streams, or in which lie the deep Highland lakes. Different parts of the Grampian country receive different names—the **Breadalbane Mountains,** the **Moor of Rannoch,** and the **Monadliath Mountains** are examples. Ben Nevis rises near the fault valley of Glenmore to a height of 4400 feet above sea-level, the highest summit in the British Isles. This " mountain " is part of a huge granite mass. Another dissected granite mass forms the group of bold mountains near the source of the Dee—Cairn Gorm, Cairn Toul, Braeriach, and Ben Macdhui, all rising to 4000 feet above sea-level.

Among the Highlands—in the outer Isles, in the Northern Highlands, and in the Grampian Group—are numberless narrow, deep lochs. Some of the grander and more famous of these are Lochs Shin, Assynt, Maree, Quoich, and Shiel, north of Glenmore, and Ericht, Rannoch, Tay, Awe, and Katrine in the mountains south of Glenmore. The northern part of Loch Lomond is a true Highland lake, the southern part is of Lowland type, for the boundary fault crosses the lake, so that the largest of Scottish lakes is partly in the Highlands and partly in the Lowlands. Loch Morar, in the west of the Northern Highlands, is the deepest lake in Britain.

A heavy rainfall gives rise to countless streams, and the rapid fall of the floor of the glens causes the rivers to flow rapidly and with few windings to the sea or to the Lowlands. The water-divide is so near the broken western coast that there are no long rivers on that side, but towards the north-east, east, and south-east some well-known rivers flow from the Grampian

masses. The Spey, the Dee, the Tay, and the Forth are famous in all Highland lore, and among sportsmen for their trout and salmon.

The western coast of the Highlands is quite different from the eastern. The former is cut up by a thousand inlets and channels, a true fiord system. From Loch Eriboll in the north to Loch Long in the south-west there is a magnificent succession of the long, narrow, and deep openings which have all the characters of true fiords. Some of these sea-lochs extend far inland, and from their sides and ends the rugged mountains rise sharply, leaving little room for a coastal strip of cultivated land. Loch Long, Loch Fyne, Loch Linnhe, Loch Eidart, and Loch Torridon may be taken as examples.

The rocks of the Highlands are hard and contain little mineral wealth ; the soil is often thin and poor ; the rainfall is heavy, the climate damp and raw. Hence means of livelihood are scanty, and the Highlander has to go to the seas and rivers for much of his wealth. His little clearings of oats and barley often fail him, for the crops do not always ripen in the wet summer and autumn. There is but little wealth of any kind in the Highlands, except it be in the abundant water supply which could be obtained in every glen. But that is far removed from the populous regions of Britain. Hence the Highlands are largely given over to the sportsman and the tourist. Deer forests, grouse moors, salmon and trout streams count for much in the wealth of this region. The tourist is also a source of wealth. A good deal has been written about the waste involved in allowing so much of Scotland to remain unproductive. Much of it could not be made very productive, however. Of course, extensive ploughing is out of the question, and much of it is too rocky and barren for numerous sheep or cattle. The only hope of producing greater wealth would seem to be in the systematic planting of forests, and this has only recently been made a national concern.

The Midland Valley of Scotland—*The Lowlands.*

This well-defined region lies between two great boundary faults, which are roughly parallel to each other. The Highland boundary line has been mentioned already; the boundary of the **Southern Uplands** extends from St Abb's Head to Girvan, and is not quite so clearly defined as the more northerly line. The **Midland Valley** is a trough-valley or rift-valley, the rocks having been let down between the two fault boundaries. It has already been pointed out that the rocks of the Highlands are very old and very much altered; but the rocks of the Midland Valley are somewhat newer, belonging to the Devonian and Carboniferous systems.[1] (See Map, fig. 4.)

The Midland Valley is by no means a plain, and only deserves the name **Lowlands** relatively when compared with the neighbouring Highlands and Southern Uplands. There are prominent hills in this trough-basin, which are due to large masses of igneous rock having been thrust through the sedimentary rocks and poured out on the surface. These igneous rocks are largely responsible for the two lines of hills which run somewhat parallel to the boundaries. The Sidlaws, the Ochils, Campsie Fells, and Renfrew Heights are the northern set; the Pentland Hills, the Braid Hills, and the Kilpatrick Hills the southern set. Some parts of the Ochils are over 2000 feet in height. **Strathmore** or the **Great Plain** lies to the north-west of the northern line of Midland hills, a fertile plain of Old Red Sandstone. The **Carse of Gowrie** is a smaller plain lying between the Sidlaw Hills and the Firth of Tay. Between the Pentland Hills and the Firth of Forth are the **Lothian Lowlands,** a region underlain chiefly by Carboniferous rocks.

The four hill-masses of the northern series are separated by the three great Lowland rivers—the **Tay,** the **Forth,** and the **Clyde.** Rising in the neighbouring mountain regions, these rivers cut across the boundary faults, and flow through

[1] Always refer to the table of rock-systems on p. 235.

the Lowlands to the great drowned estuaries which allow shipping to penetrate into the very heart of the industrial regions of the Scottish Midlands.

Three coal-fields occur in this Lowland trough : in the west that of **Ayrshire,** in the middle the rich **Lanark** coal-field, stretching across East Stirling to Clackmannan, and in the east the **Lothian** coal-field, with an important extension into Fifeshire across the wide Firth of Forth. (See Map, fig. 4.)

The soil of the Old Red Sandstone and Carboniferous Limestone districts of the Lowlands is fertile. It has been carefully worked for a long time now, and some of the farming on the plains mentioned above is famous for its thoroughness. Wheat, barley and oats, roots and potatoes are successfully cultivated by the thrifty Scottish farmers. The Carse of Gowrie and some parts of Strathmore are famous for apples, pears, plums, raspberries, and strawberries. The farming of the Lothians has been claimed to be the most thorough in the world.

The Southern Uplands of Scotland.

This is the third distinct region of Scotland. The boundary line runs from St Abb's Head on the east to near Girvan on the west. South of this boundary there is a different type of country—wide, rounded moorlands separated by V-shaped valleys (not glens). These uplands occupy almost all the country from sea to sea, and from the fault boundary to a line drawn from the Solway to Berwick. The north-eastern rampart is formed by the **Lammermuirs,** the **Moorfoot Hills,** and the **Haughshaw Hills,** which overlook the Lothian Lowlands. In the middle of the Uplands are the **Lowther Hills,** with Broadlaw, Hartfell, and Queensberry Hill (over 2600 feet). To the south-west rises Merrick, 2700 feet, the highest point in Southern Scotland. (See fig. 7.) On the southern side the Uplands gradually merge into the Cheviots.

These Uplands are intermediate both in height and in

ruggedness of structure between the Highlands and the Midland trough. Though the rocks are considerably folded and faulted, there is neither such complexity of structure nor evidence of extreme disturbance as may be seen in the Highlands. There are a few lakes in the eastern part, but they are quite unlike those of the Highlands. In the south-western part, west of Nithsdale, there are numerous lakes, but these again are not of the Highland type. The coast is also quite different, for there are no true fiords like those on the west coast of the Highlands.

The Southern Uplands are almost everywhere soil-covered, and there are few parts where bare crags occupy the surface as in so much of the Highlands. Hence good farming is possible, and a great deal of the surface is enclosed by stone fences. The lower parts of the valleys are well farmed, not a little oats, barley, and turnips being grown. The moorlands feed vast numbers of sheep, and the counties of Berwick, Roxburgh, and Selkirk are among the most famous sheep-rearing areas in Britain. Dairy-farming, cattle-rearing, and horse-breeding are carried on extensively, especially in the western part of the Southern Uplands.

The granite areas of Criffel and Loch Doon send much granite to the industrial and more thickly populated parts of Britain. Some lead ore and barytes are obtained from the Lowther Hills.

Three river systems drain most of the Southern Uplands. In the east is the **Tweed** system, the main stream rising in the high middle region already mentioned and flowing almost directly east to the North Sea. Its chief tributaries come in on the right bank, and the Yarrow, Ettrick, and Teviot are like the Tweed itself, famous in the poetry, border-minstrelsy, and ecclesiastical history of the region. The **Clyde** rises in the same central hills as the Tweed, and, escaping from the Uplands, cuts across the faulted boundary at right angles to proceed north-westwards over the Old Red Sandstone before

reaching the coal-field. The **Solway** rivers, the Dee, Nith, Annan, and Esk, flow independently to the wide reaches of

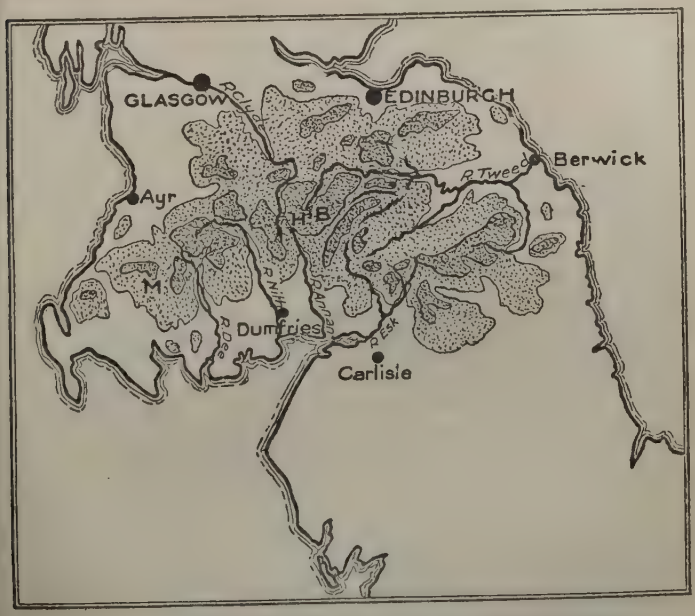


FIG. 7.—THE SOUTHERN UPLANDS AND THE CHEVIOTS.
Land over 600 feet is lightly stippled; over 1200 feet more closely stippled.
Abbreviations.—B., Broadlaw; H., Hartfell; M., Merrick.

the shallow "firth" which separates the Cumberland angle of England from the rugged shores of the south-west of Scotland.

CHAPTER III

THE STRUCTURE OF THE BRITISH ISLES—NATURAL REGIONS (*contd.*)

UPLANDS OF ENGLAND AND WALES

The Pennines.—As we pass southward over the Cheviot border we find ourselves in a land of broad moors which stretch acros the country from the Solway lowlands to the rocky North-umbrian coast. This is the northern extension of the Pennine system of Carboniferous moors,[1] stretching for a hundrec miles from the **Tyne Gap** to the **Vale of Trent.** The rocks of the Pennines consist almost entirely of Carboniferous Limestone, Millstone Grit, and Coal Measures, the three chie formations of the great Carboniferous system. (See fig. 8.) The special and local characters of the " mountains " depend upon which of the three formations appears at the surface The **Coal Measures** occur mainly on the flanks, and the three great Pennine coal-fields underlie three of the busiest industrial regions in Britain. The sandstones and shales of the Coa Measures do not as a rule furnish a fertile subsoil, and it is the rocks themselves—coal, fire-clay, shale, and sandstone—which furnish so much of the wealth of those parts of th country. Where the **Millstone Grit** is the chief rock, there are often wild, barren, peat-covered moors largely given over to sheep-rearing and the " preservation " of grouse for th sportsman. Where the **Carboniferous Limestone** is the surface rock, there is usually very charming scenery—deeply-

[1] The moors *north* of the Tyne Gap are best grouped with th Cheviots.

cut dales, high scars and tors, waterfalls, caves, and underground streams.

The Pennines are divided into Northern and Southern parts.

FIG. 8.—SIMPLIFIED GEOLOGICAL MAP OF THE NORTH OF ENGLAND.

To show the Geographical Divisions, especially of the Northern Pennines. Note the faults marked by thick black lines.

Key to abbreviations.—1. Granite masses. 2. Lower Palæozoic Rocks. 3^a. Carboniferous Limestone. 3^b. Millstone Grit. 3^c. Coal Measures (in coal-fields). 4. New Red Sansdtone (Permian Trias). 5. Jurassic Rocks. 6. Cretaceous Rocks (chalk, etc.).

The **Northern Pennines** occur north of the well-known Craven Gap, in the middle of which stands Skipton. North of this gap the Carboniferous Limestone is the prevailing formation, with patches of Millstone Grit here and there forming the summits of the higher hills or occurring in belts to the east and west of the region. This Northern part may be regarded

as a series of three blocks of table-land, each bounded by one or more prominent faults. The **Cross Fell** block is bounded by the Tyne Fault to the north, and by the fine scarp of the Pennine Fault to the west. On the eastern side this plateau-block slopes gradually towards the Northumberland-Durham coal-field. The second plateau-block, that of Dent and Hawes, is not so clearly defined. It may well be called the "**Mallerstang Block,**" Mallerstang being the name of the wild upland country south of Kirkby Stephen. This plateau-block adjoins the Howgill Fells, formed of rocks similar to those of the Southern Uplands. The third block is that of **Ingleborough** and **Penygent,** sharply bounded on the south-west and south by the Craven Fault. The position and relation of these plateau-blocks may best be understood by studying a geological map of the Northern Pennines. All this Northern Pennine land is thinly peopled—a land of sheep-farming on the higher ground, and of dairy-farming and stock-rearing in the valleys. The valleys are famous for their fine scenery—the Tees, Swale, Yore, and Wharfe, which open eastward, and the Eden, Lune, and Ribble, which drain to the west.

The **Craven Fault** sharply divides the plateau-block of Penygent from the lowland and rolling country to the south-west. Here rise the wild grit moorlands called the **Bowland Fells,** and the grit scarp of the **Pendle Range.** Here also, due to the cutting back of the Aire and the Wharfe systems from the east, and the Ribble and Wenning on the west, is the famous passage through the Pennines already mentioned. From the lowland Craven country in the middle of this "**Craven Gap**" railways now carry the passenger outwards in five directions—three on the west, two on the east. Leeds and Bradford guard the eastern end of the pass; the Blackburn-Burnley group of towns occupy a similar position on the western side.

South of a line drawn from Blackburn to Leeds, the **Southern Pennines** extend to the Vale of Trent. The structure is here

somewhat different. From the axis of the moorlands one passes outwards over newer and newer strata as one proceeds to the east or to the west. From the neighbourhood of Nelson and Keighley wide moors of Millstone Grit extend southwards to the **Peak** country of Derbyshire. These moors are wild, barren, and very thinly peopled, but important because they supply such enormous quantities of water to the busy industrial towns near. The **South-East Lancashire Coal-field** adjoins the moorlands on the western side, and the **West Riding Coal-field** on the eastern side. On both sides the Coal Measures pass underneath the plain of New Red Sandstone, on which mining and manufactures give place to agriculture to a considerable extent. (See fig. 9.)

South of the Grit country of the Peak, the Pennine upfold has been cut down so far that the Limestone is exposed over wide areas, and here is the beautiful country of the **Derbyshire dales,** with its fine high tors and deep gorges at Buxton, Matlock, Monsal Dale, and Tissington. In this Southern Pennine area the **North Staffordshire Coal-field** corresponds to the **Derby-Nottingham Coal-field** on the eastern side ; in each case the Coal Measures pass underneath the New Red Sandstone beds of the plains.

This **Southern Pennine** region, with its great coal-fields, is probably the most important industrial region in the world. Draw a line immediately south of Derby from the city of Nottingham to Stoke ; then one across Cheshire and Lancashire to Warrington and Preston ; from Preston follow the Ribble to the Craven Gap and the Aire to a little east of Leeds ; complete the quadrilateral by drawing a line from east of Leeds to Nottingham, so as to include the industrial area of the Eastern Pennine coalfield ; the great industrial region thus enclosed contains a population of over ten millions of people, even though it includes the thinly-peopled Millstone Grit moors already mentioned.

No description of the geography of the Pennines would be

complete without some reference to the two prominent moorland groups which stand out from the Pennines towards the Lancashire Plain. These are the **Bowland Fells** and the **Rossendale Fells.**

The **Bowland Fells** are a group of Millstone Grit moors

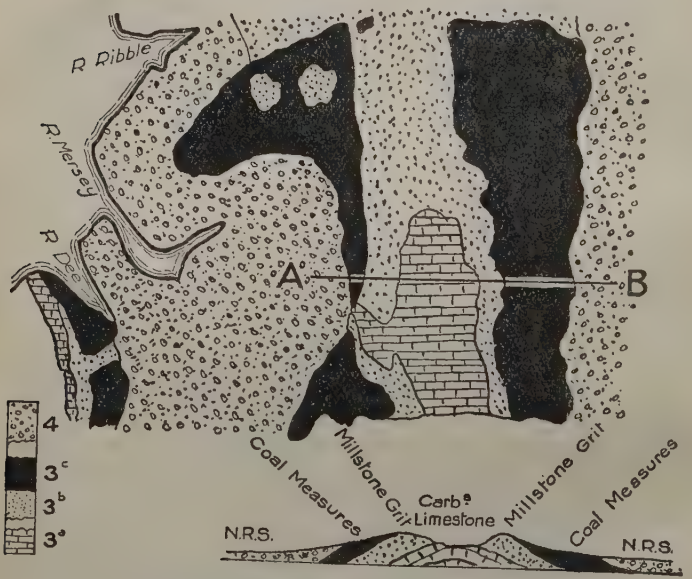


FIG. 9.—GEOLOGICAL MAP AND SECTION OF THE SOUTHERN PENNINES AND THE NEIGHBOURING PLAINS.

The section is taken along the line A B. Key to shading, see Fig. 8.

which lie between the valleys of the Lune and Ribble, and end somewhat abruptly in a line of heights overlooking the Fylde Plain. These fells are drained by the Hodder, a tributary of the Ribble, the Wyre, which afterwards flows across the North Lancashire Plain and empties itself into the south-western end of Morecambe Bay at Fleetwood, and the Roeburn, a feeder of the Lune system. Ward Stone Fell, Wolf Crag, and Bleasdale Moor are prominent hill-masses. A famous pass

is the **Trough of Bowland**, through which runs the moorland road from Clitheroe to Lancaster. In the upper valley of the Hodder is the interesting old market-town of Slaidburn, nestled among wild fells.

This region of Bowland—the "Forest of Bowland"—is very thinly peopled, and as yet no railway penetrates it. In this respect it contrasts sharply with the **Rossendale Fells** to the south. These latter fells extend from the neighbourhood of Burnley and Rochdale to the South Lancashire Plain. They, too, are Millstone Grit moors, but with patches of Coal Measures. Great Hambledon, Rivington Pike, Musbury Tor, Coupe Law, and White Hill are prominent hill-masses.

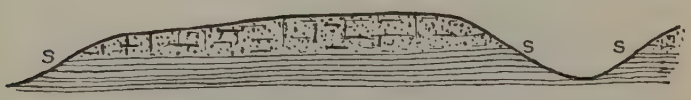


FIG. 10.—POROUS SANDSTONE RESTING ON IMPERVIOUS SHALE.
Water will pass through the sandstone until it reaches the shale; there will be springs at S S.

Three railway lines—parts of the London, Midland, and Scottish system—cross the Rossendale Fells from north to south, connecting the Ribble-Calder group of towns with the Irwell group to the south. These railways connect the Burnley-Blackburn and the South Lancashire coal-fields, and thus join busy industrial regions. There is no similar coal-field in the Lune Valley to warrant railway lines across the somewhat higher fells of Bowland.[1]

The Rossendale Fells receive a rainfall of at least forty inches distributed fairly well throughout the year. This rain soaks into the Grit moors and comes out in innumerable springs as plentiful supplies of soft water. (See fig. 10.) This is one cause of the great number of bleach-works, dye-works, paper-mills, and tanneries which are located among and on the edges of

[1] There is a small coal-field at Ingleton.

these fells. Between the Bowland Fells and the Rossendale Fells is the lateral **Pendle Range,** the highest point of which is Pendle, a fine hill overlooking the Ribble Valley on the north and the Burnley Basin on the south.

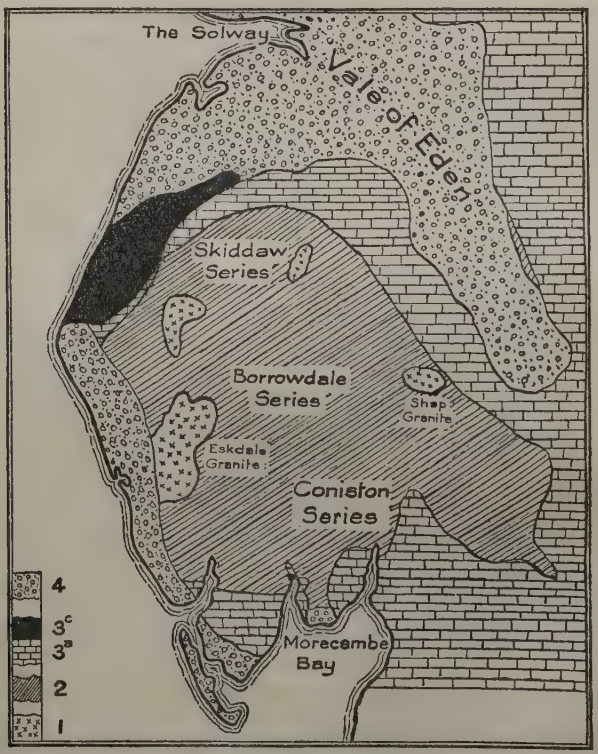


FIG. 11.—SIMPLIFIED GEOLOGICAL MAP OF THE LAKE DISTRICT.

For Key, see Fig. 8.

The Lake District.—This name is given by common consent to the region which lies between the Northern Pennines and the New Red Sandstone extensions of the Vale of Eden and Morecambe Bay. It contains a central area of old sedimentary

rocks, varied with dissected masses of igneous rocks. The rocks are frequently slaty in character. The oldest occur in the northern part of the central area, and are usually known as the **Skiddaw Series.** Skiddaw, Blencathra, and Carrock Fell are the best-known mountain masses in this sub-region. (See fig. 11.) A middle belt consists of old volcanic lavas and volcanic tuffs usually called the **Borrowdale Series.** The best-known mountains of the Lake District are in this central belt, among which are Great Dodd, Helvellyn, and Fairfield; the Langdale Pikes, Scafell, Scafell Pike; Great Gable, Robinson, Pillar, and Steeple; and Coniston Old Man, and Black Combe. A southern belt consisting of flagstones and limestones is known as the **Coniston Series.** An eastward extension of Lake District rocks connects the southern part of the Lake District to the Northern Pennines. This extension forms the **Shap Fells** and the **Howgill Fells.** The finest and highest part of this division is in the triangular patch of country between Sedbergh, Tebay, and Kirkby Stephen, where the **Langdale Fells** rise to over 2200 feet.

The whole Lake District region and the Howgill Fells have been aptly compared by Professor Marr to a shallow spoon with a broad handle. The inverted spoon is, of course, the Lake District proper; the broad handle is attached to the Pennines where Wild Boar Fell and Baugh Fell rise to heights of 2300 feet and 2200 feet respectively.

A crescent-shaped rim of Carboniferous Limestone, of varying width, extends round the Lake District on the eastern side, from Askam and Millom on the south-west to Cleator Moor on the north-west. This is of considerable importance because iron ore is found in veins and pockets of the limestone. This ore has given rise to the important smelting industry of Barrow and Ulverston in the south, and Cleator Moor, Moss Bay, and Workington in the north.

On the north-western side lies the small coal-field of Workington and Whitehaven, reaching the coast continuously from near

St Bees to Maryport and extending inland for almost a dozen miles. This coal-field is the foundation of the industrial region of West Cumberland.

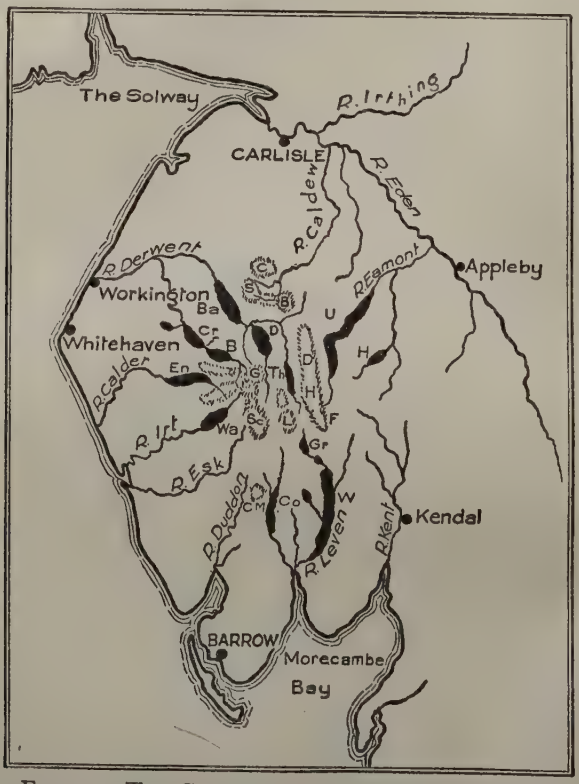


FIG. 12.—THE CHIEF PEAKS, RIVERS, AND LAKES OF THE LAKE DISTRICT.

Peaks.—D., Great Dodd; H., Helvellyn; F., Fairfield; C., Carrock Fell; S., Skiddaw; B., Blencathra or Saddleback; G., Great Gable; Sc., Scafell; L., Langdale Pikes; C.M., Coniston Old Man.
Lakes.—U., Ulleswater; Th., Thirlmere; D., Derwentwater; Ba., Bassenthwaite; B., Buttermere; Cr., Crummock Water; En., Ennerdale; Wa., Wastwater; Co., Coniston Water; Gr., Grasmere; W., Windermere; H., Hawes Water.

An important feature of the **Lake District**, as the name indicates, is the series of long, narrow, and deep lakes which

occur in so many of the valleys. They lie in a series of river valleys arranged in somewhat radial fashion, draining to the Eden, the Irish Sea, and Morecambe Bay. Going round the district from east by north the lakes are as follows :—Hawes-water, draining to the Eden ; Ulleswater, drained by the Eamont, a tributary of the Eden ; Thirlmere, Derwentwater, and Bassenthwaite, drained by the Derwent and its tributaries ; Buttermere, Crummock Water, and Lowes Water, drained by the Cocker to the Derwent, the united drainings of these and the last group reaching the sea at Workington ; Ennerdale Water and Wastwater, draining to the Irish Sea across a narrow plain ; Coniston Water, Grasmere, Rydal Water, Easthwaite Water, and Windermere, draining to the northern part of Morecambe Bay ; and finally, the small lakes, Kentmere and Kentmere Tarn, drained by the Kent to the north-eastern corner of Morecambe Bay. (See fig. 12.)

The Lake District is a favourite haunt of naturalists, painters, and " men of letters." Wordsworth, Southey, John Ruskin, " George Eliot," among poets, essayists, and novelists, have resided there and have sung its praises. It is one of Britain's most charming and most frequented holiday resorts, and catering for tourists and holiday-makers is now one of its important " industries."

It is too wet for cereals, and sheep and cattle employ the farmer, the former being the more important of the two. Some lead mining is carried on; tungsten and other metals are mined round Carrock Fell ; plumbago (black-lead) was formerly obtained in Borrowdale, and gave rise to the pencil industry of Keswick. The plumbago is now obtained from Spain or Canada, and the cedar wood from Florida. In the central and northern parts of the Lake District slate is quarried, the famous green slate of Westmorland and Cumberland being fine-grained volcanic ash which has been so compressed that it cleaves readily into thin slabs and forms a good, durable roofing slate. Granite and other igneous rocks are quarried

for paving-stones and road-metal. The famous granite of Shap Fell, with its large crystals of pink felspar, is a favourite ornamental building stone, which may be seen in many a well-known public building.

The Welsh Highlands and the Welsh Borderlands.—There is some similarity in general structure between Wales and the Lake District, with considerable difference in detail. The Welsh Highland region consists of the same old sedimentary rocks and similar igneous rocks. Wherever igneous rocks occur in plenty, they add variety to the scenery ; especially is this the case in the northern and southern peninsulas of Wales.

Outside the older rocks of Wales is a variable border of somewhat newer rocks, stretching almost continuously from Northern Anglesea to the Pembroke Peninsula in South Wales. A belt of Old Red Sandstone runs from Pembrokeshire through Caermarthenshire and Brecknockshire into Herefordshire. It occupies the greater part of the latter two counties. This belt reappears on the south side of the great South Wales Coal-field, in Monmouthshire, and in the peninsulas farther west. (See fig. 13.)

The Carboniferous rim of Wales includes important **coal-fields.** In North Wales is the coal-field of Flint and Denbigh, extending from Mostyn at the mouth of the Dee to Oswestry. Flint, Mold, Wrexham, and Ruabon are the mining " centres " of this long, narrow coal-field. Irregular patches of Coal Measures stretch almost continuously across Shropshire, and continue as far as Abberly Hill in North Worcestershire. In Gloucestershire—west of the Severn—is the small, compact coal-field of the **Forest of Dean,** a coal-field which played an important part in the early days of the Industrial Revolution. The greatest coal-field of Wales and the Welsh Marches is, however, that of **South Wales.** From Pontypool in Monmouthshire to Kidwelly in Caermarthenshire, a distance of some sixty miles, extends one of the richest of British coal-fields. The river valleys run across it from north to south

towards the Bristol Channel, and along the banks of these transverse valleys the coal-beds lie well exposed, and in the early days of coal-mining were easily worked. A western extension of the South Wales coal-field stretches across Mid-

FIG. 13.—SIMPLIFIED GEOLOGICAL MAP OF WALES AND ADJACENT PARTS OF ENGLAND.

Key to shading.—1. Granites and other igneous masses. 1^a. Pre-Cambrian (Archæan) Rocks. 2. Lower Palæozoic Rocks. 2^a. Old Red Sandstone. 3^a. Carboniferous Limestone. 3^b. Millstone Grit. 3^c. Coal Measures (in coal-fields). 4. New Red Sandstone. Compare figs. 4, 8, 9, 11.

Pembrokeshire from Caermarthen Bay to St Brides Bay. **Anthracite,** the smokeless coal, is obtained from this Pembrokeshire field, as well as from the western part of the larger coal-field. A great deal of coal is exported from the South Wales coal-field.

A review of the Welsh region shows the intimate dependence

of surface features upon underlying rock structure. Where the igneous rocks are abundant, both variety of scenery and increased resistance to erosion seem to follow. The northern and southern peninsulas are apparently due to the numerous igneous rocks of the Snowdon and the St David's regions. **Snowdonia** is the highest part of Wales. Here are seen many of the features of the Lake District. Snowdon, Glyder Fawr, Carnedd David, Carnedd Llewellyn, and Moel Siabod are well-known mountain masses. The " passes " between these mountains are as famous as the peaks themselves : Capel Curig, Bethesda, Llanberis, and Aberglaslyn are perhaps the best known. Small lakes lie on the flanks of these North Wales mountains. These lakes are gloomier and wilder than those of the Lake District.

The best roofing slate of the British Isles is obtained from Snowdonia. At Penrhyn, Llanberis, and Blaenau Festiniog are large quarries. The slate is exported from numerous small ports scattered along the coast. Paving-stones and road-metal are obtained in large quantities ; well-known localities are Penmaenmawr, Pwllheli, and Llangynnog. Granite is quarried at Nevin, and there are many other localities. Manganese ore is obtained from near Rhiw in the Lleyn Peninsula. Lead and zinc ores occur in the Carboniferous rim on the east side of Snowdonia.

South of Snowdonia are the **Berwyn Mountains** and the Arenigs, with beautiful Bala Lake and the upper valley of the Dee between them. The Berwyns are separated from the eastern part of Snowdonia by the Pass of Llangollen, where the Dee cuts through the narrow rim of Carboniferous Limestone. Cader Berwyn, Arenig, Aran Mowddy, and Cader Idris are prominent mountains. Liverpool obtains its chief water supply from the artificial Lake Vyrnwy in this region. Gold is obtained in paying quantities in Merionethshire, near the edge of a large granite mass. Manganese ore is found near Barmouth.

In **Mid-Wales** igneous rocks are practically absent, and the old slates, grits, and limestones are weathered into lower and less rugged hills. Plinlimmon in North Cardiganshire and the Breidden Hills in East Montgomeryshire are the more prominent hills.

The **Severn** rises on the slopes of Plinlimmon and breaks through the hills of East Wales to flow through Shropshire between the Wrekin on the north and the Longmynd and the Clee Hills on the south. The Longmynd and the Wrekin in Shropshire reveal some of the oldest rocks in England. Lead, silver, and zinc ores are obtained in Montgomeryshire, and slate is also quarried. Silver, lead, and zinc ores occur in the rocks of Shropshire.

In South Wales are the **Black Hills** and the **Beacons of Brecknockshire,** the former rising to 2600 feet. These hills occur in the Old Red Sandstone which occupies the greater part of Brecon county. Here the features of the country take on that east-to-west direction which makes South Wales similar in build to the south of Ireland and the Mendips. Lead, zinc, and copper ores occur in the older rocks of South Wales, and gold was mined in Caermarthenshire by the Romans.

The Welsh mountains are the homes of great numbers of sheep, and Welsh mutton is, of course, famous. The woollen industry of the Severn Valley in Mid-Wales is obviously related to the plentiful supply of wool. It furnishes a good example of what is named " industrial inertia," for the industry which was built up in the days before steam power was used has been maintained by coal drawn from the Severn Valley coal-fields on the Welsh borderland.[1] Wales is not famous for cattle as a rule, but there are two exceptions. The lower lands of Pembrokeshire and the Isle of Anglesey are both noted for their rich pastures, and for their excellent breeds of cattle. Anglesey is one of the most noted cattle areas in the British Isles.

[1] It is said to be declining rapidly now.

The South-Western Peninsula.—This is a well-defined region, for, although the New Red Sandstone sends a narrow wedge into the **Vale of Crediton,** and also forms an interesting fringe from Exeter to Teignmouth and again in Tor Bay, the peninsula is essentially Devonian and Carboniferous, with great masses of granite. The Devonian rocks—broadly of the same age as the Old Red Sandstone of Scotland and of

FIG. 14.—GEOLOGICAL MAP OF DEVONSHIRE AND CORNWALL.
Key.—1. Granite Masses. 1a. Gabbro and Serpentine of the Lizard. 2. Devonian (of the same age as Old Red Sandstone, but different in character). 3b. Carboniferous (of the same age as Millstone Grit, but different in character). 4. New Red Sandstone.

Herefordshire, but quite unlike them in character—are slates, hard sandstones, and hard limestones. The Carboniferous rocks, which stretch as a broad belt across Mid-Devon, are hard shales, slates, and sandstones of about the same age as the Millstone Grit of the North of England. In North Devon are rocks of Devonian age stretching from Wivelscombe and Minehead to Ilfracombe. Much of this moorland mass is in West Somersetshire, the highest parts of **Exmoor** being in that county. Exmoor is in appearance very much like the Millstone Grit moorlands of the Southern Pennines. The valleys—the famous "**Combes**"—are, however, cut deeper and wider,

and the splendid pinewoods are on a far larger scale than those of the Pennines. The Devonian rocks and the Carboniferous rocks of the northern coast of Devon and Cornwall are wonderfully contorted, and have been worn by the ceaseless attacks of the Atlantic waves into a thousand varied forms. The coast from Minehead to Bude, and the *Lorna Doone* country of the interior make a beautiful and interesting combination.

South of the Exmoor mass is the broad belt of Carboniferous rocks, forming generally a well-wooded, rolling country; and in the very middle of this belt is the narrow, wedge-shaped **Vale of Crediton**, similar in structure and scenery to the Vale of Eden. This Mid-Devon vale contains some arable land and rich pasture land, and is famous for its cattle and its dairy produce. (See figs. 14 and 29).

South of the New Red Vale of Mid-Devon occurs the vast granite mass of **Dartmoor.** This stands up as a broad, infertile moor, with much bog and coarse grass, into the heart of which creep some of the lovely valleys of Southern Devon. The weathering and decomposition of the granite, continued through long ages, has produced the fine white clay which is found in many of the hollows on the edge of the granite mass. This kaolin is " quarried " or dug and exported, to be made into the finer kinds of earthenware. The south coast of Devon is perhaps even more varied than the north coast; and from Exeter to Plymouth there is a wonderful succession of bays, capes, and estuaries. The latter appear to be drowned river valleys, and are often of great beauty. The **Dart** is justly reckoned one of England's grandest rivers, and the sail from Dartmouth up to Totnes—the river winding in and out among the woods—shows glimpses of scenery not readily surpassed.

Cornwall consists mostly of Devonian slates and sandstones, with granite masses forming the low moors such as Bodmin Moor. The interior is frequently rather monotonous, as the

moors are broad and the land only reaches a moderate elevation. But the coast is of singular beauty and variety. The gabbro and serpentine of the **Lizard,** the granite of **Land's End,** the Devonian rocks of Tintagel, and the cliffs of contorted rocks at Bude, are all worn into fantastic shapes. In the days of smuggling, scarcely any coast could have lent itself so well to that fascinating and lucrative breach of the country's laws.

The great granite masses were thrust up into the sedimentary strata as gigantic bosses, giving off many dykes and veins which penetrate the sedimentary rocks. Near the contact of the granites and the granite vein-rocks with the " country rock " occur many of the ores for which Cornwall has so long been famous. Tin, lead, zinc, copper, arsenic, bismuth, chromium, and tungsten are all found in some considerable quantity in the South-Western Peninsula. The reader will recall that the British Isles were probably first known because of the tin ore of the south-west, the traders from the Mediterranean being attracted by the reports of the Gauls that tin could be obtained in the islands and peninsulas across the seas.

CHAPTER IV

THE STRUCTURE OF THE BRITISH ISLES—NATURAL REGIONS (*contd.*)

ENGLAND AND WALES

THE ENGLISH LOWLANDS

AN irregular line, drawn from the cliffs of Sunderland to the corner of Devonshire where the Exe and the Teign come down from the moors, separates the two halves of England almost completely—the more rugged north and west from the more fertile England of the Midlands and south-east. This latter half of the country, which has a foundation of newer rocks, sends out important branches into the older and more rugged lands. On the other hand, there are islands of older rocks standing up among the covering of newer strata in the Midlands, and these add variety to the newer lands.

We recognise four chief divisions :—

(1) The Midland Plain of New Red Sandstone ;
(2) The Scarplands ;
(3) The Tertiary Basins ;
(4) The Fen Lands.

Each of these will be described in some detail.

The New Red Sandstone Plain.—The main part of this lowland region is in the very heart of England, covering most of the county of Warwick, much of Staffordshire, and parts of Derbyshire and Leicestershire. From this triangular-shaped Midland area three great arms or branches extend to N.W.,

N.E., and S.W. These are (*a*) the **Midland** or **Cheshire Gate,** leading towards the Irish Sea, including the Lancashire and Cheshire or North-Western Plain; (*b*) the **Yorkshire** or

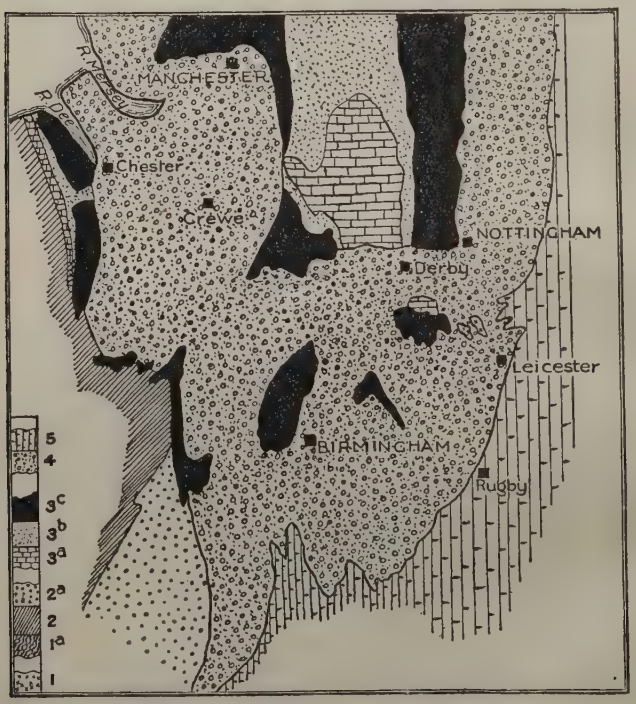


FIG. 15.—GEOLOGICAL MAP OF THE MIDLAND AREA OF NEW RED SANDSTONE, WITH ITS ISLANDS OF OLDER ROCKS.
(See figs. 8 and 13 for key to shading.)

North-Eastern Plain, extending through Nottinghamshire and Yorkshire to the mouths of the Tees and Wear; (*c*) the narrower and more irregular belt of New Red Sandstone of the **Severn Gate,** which continues across the south-west to Teignmouth and Paignton at the south-eastern end of Devonshire.

The rocks are soft, red or yellowish and mottled sandstones, pebble beds, and marls, which yield a fertile and open soil. The land is therefore among the richest in Britain, both good arable land and rich pasture land occurring. The chief crops are potatoes, turnips, oats, and barley; and there are rich pasture lands such as the fertile dairy-lands of Cheshire. Strawberries are produced in large quantities in some parts of this fertile plain.

We generally say, "The New Red Sandstone *Plain*," but it is by no means a flat land; it is for the most part a rolling country, with a good deal of scattered timber among its rich meadows—the typical "Park-land" of the English Midland shires. The Avon of Tom Brown's school-days flows across the south-eastern edge of this New Red Plain, and Coventry, Warwick, Stratford-on-Avon, and Leamington are well-known places where the typical "New Red" country may be seen.

The three long arms of the Plain have already been mentioned; they may now be treated more fully. The North-Western Plain branches off from the real Midlands as the **Cheshire** or **Midland Gate** between the uplands of the Southern Pennines and North Wales. It continues as the **Lancashire and Cheshire Plain** to the Irish Sea and Morecambe Bay. In Cheshire some of its harder red sandstones stand up as "hills" of a few hundred feet high—the Peckforton Hills and the high ground of Alderley Edge. For the most part, however, the land is a plain with a plentiful covering of boulder clay and other recent deposits. In South Lancashire an area of Coal Measures partially separates the Manchester bay of New Red Sandstone from the Preston angle. The newer rocks form a broad belt on the outer side from Liverpool through Ormskirk to Preston. There is much boulder clay and other glacial drift, and peat mosses are common. **Chat Moss,** about a dozen miles west of Manchester, will always be famous on account of the difficulties which George Stephenson had to overcome in carrying his Liverpool-Manchester

railway across it. The New Red Sandstone reappears across Morecambe Bay in the flat land of Furness Abbey, Barrow, and Walney Island. A narrow border extends north-westward along the coast of Cumberland past Bootle, Ravenglass, and Seascale to the fine headland of St Bees. Furness Abbey, at the southern end of this narrow belt, was built of the red sandstone of that region.

After a short break, the New Red Sandstone reappears again in the **Vale of Eden.** From Kirkby Stephen in Westmorland there extends north-westward a fertile vale underlain by the New Red Sandstone rocks. Appleby, the county town of Westmorland, lies in the upper part of the plain, Penrith in the middle part, and Carlisle on the wide lower plain where the New Red Sandstone rocks extend outwards to Silloth and Allonby. To appreciate fully the meaning of this plain, and to understand the influence of rocks on scenery, agriculture, and general geography, the observer should take his stand on the fine, bold scarp of Carboniferous Limestone above Melmerby or Kirkland and look to the south-west. Immediately in front of him is the great **Pennine Fault** by which the Carboniferous Limestone on which he is standing at a height of over 1000 feet is let down and covered by the New Red Sandstone deposits of the Plain. Immediately beyond the fault is the fertile land of the Vale of Eden, with its patchwork of ploughed fields and pasture land, and its scattered woodlands. The towers of a score of churches, each indicating a village, appear among the trees and meadows. The Eden may be seen winding through the middle of the valley, and on either side may from time to time be noticed the white trail of the express trains of the two great main lines which use this broad vale. Beyond the Eden Valley rise the sharp peaks of the Lake District hills, flanked on the near side, however, by the fertile strip of Carboniferous Limestone.

Finally, we may note that across the Solway there is a still further branch of the New Red Sandstone Plain extending

beyond Dumfries. Here a red sandstone is the prevalent building-stone, and its warm red colour furnishes an agreeable contrast to the rich green of the fertile vale. The former Glasgow and South-Western Railway uses this valley, just as the former Midland and London and North-Western Railways use the wide valley of the Eden across the border.

The North-Eastern Extension.—On the other side of the Pennines there is the North-Eastern Plain of New Red Sandstone. Starting from the Midlands, this arm extends through the counties of Nottingham, Yorkshire, and Durham, between the Pennine moorlands on the west and the Jurassic escarpment on the east. Much of Nottinghamshire is occupied by the various rocks of the New Red Sandstone, and here is some of the finest park-country in England. Famous **Sherwood Forest** lies on the western side of the plain towards Derbyshire; in the north of the county are the noted mansions and parks which have earned for that region the name of the "**Dukeries.**" Through South Yorkshire, past Doncaster, and on to York and Northallerton the plain continues, much of the New Red Sandstone being, however, buried under a thick mantle of recent deposits. The plain crosses the mouth of the Tees and occupies the south-eastern angle of the county of Durham.

Like the Western Plain, this eastern extension is a rich agricultural country, the variable but generally thick covering of glacial deposits and other drift adding to the fertility of the region. Nottingham, Doncaster, York, Selby, and Northallerton, well-known towns on this plain, are among the most famous agricultural markets of England.

The Severn Gate and the South-West Extension.—This opens up a narrow way between the Cotswolds, the Bristol coal-field, and the Mendips on the east, and the Welsh marches and the South Wales coal-field on the west. The New Red Sandstone extension continues across Somersetshire through the **Vale of Taunton** to Exeter and the Devon coast. In Northern Somersetshire the rocks are covered by thick alluvium,

and the fen lands of Somersetshire reproduce many of the characteristics of the Humber fenlands. As already mentioned,[1] a wedge-shaped extension of the New Red Sandstone Plain extends into Mid-Devon as part of the fertile **Vale of Crediton.** This is the central part of the famous farm lands of Mid-Devon.

In a way Taunton corresponds to Doncaster or to Chester, and Exeter to Carlisle. It is interesting, by the way, to note what a large number of the older Cathedral cities occur on the New Red Sandstone Plain or very near it.

The Scarplands.—A striking feature of South-Eastern England is the grained structure of the country S.E. of an irregular line from **Middlesbrough** to **Weymouth.** (See fig. 16.) From Yorkshire to the region south of the Thames the most important features are two long lines of limestone "hills," with clay vales in front of them to the north and west. These hills are lines of escarpments; that is, uplands having a fairly sharp edge on one side and a long slope in the other direction. In both cases limestone is the rock of which the scarped hills consist, while less resistant clays and sands form the vales. The older limestone series is the one to the north-west, and is known as the **Jurassic Escarpment.** The newer limestone is the Chalk, and its scarp is sufficiently described as the **Chalk Escarpment.** In front of the Jurassic Escarpment is a varying belt of clay and sandstone which often forms low, flat lands contiguous to the New Red Sandstone Plain. The clays of the upper part of the Jurassic system and of the Lower Cretaceous (the Chalk system) occur in the vale which lies *between* the two scarps. Hence we have two lines of clays and two lines of scarps; this is the first broad subdivision of the "Scarplands."[2]

South of the Thames and the Vale of Newbury this structure gives place to a series of broad "**downs,**" the Chalk occupying wide areas, while the Jurassic rocks occur as narrow fringes.

[1] Chap. III. p. 39. [2] See Chap. I. and figs. 5 and 6.

This band of broad downs is known by different names in different parts, and, as it would seem desirable to have one name for the whole, it is here called the "**Wessex Downs.**"

The third chief division of the Mesozoic Scarplands is the south-eastern angle of England, where there are two lines of

FIG. 16.—SIMPLIFIED GEOLOGICAL MAP OF SOUTH-EASTERN ENGLAND.

Key.—5. Jurassic Rocks. 6. Cretaceous Rocks. 7. Tertiary Strata. 8. Fenlands.

chalk escarpments (the **North** and **South Downs**), with the Weald lands between them. The Scarpland divisions will now be described in greater detail.

The Escarpments have already been mentioned in Chapter I. They extend in two roughly parallel bands from the Yorkshire coast to south of the Thames, the "grain" of the country running fairly steadily from N.N.E. to S.S.W. Like all

natural features, when traced over a considerable stretch of country there is some variation, but, broadly speaking, four minor divisions can always be made out. In front of the whole system is a flat clay land. This merges into the New Red Plain as a geographical feature, and is, as a rule, widest in the Midland counties. Gloucester, Evesham, Rugby, Lutterworth, and Grantham are on this clay plain.

Next in order comes the **Jurassic Escarpment,** mainly composed of the limestones of the Jurassic system. The escarpment has its sharp face looking towards the Midland Plain, its gentler dip-slope towards the east and south-east. The scarp-like character is most marked in North Yorkshire and on the western side of the Cotswolds, where the village names often bear evidence of it. Sutton-under-Edge in North Yorkshire, Weston-under-Edge and Wotton-under-Edge in Gloucestershire, are villages very close to the edge of the limestone scarp.

These Jurassic rocks form somewhat flat-topped "hills," or dissected plateaux, with a general slope in the direction of the dip of the beds. The **Cleveland Hills** and the **North York Moors,** in the north of Yorkshire, make the broadest plateau, in which have been cut beautiful dales drained either north-eastward to the Whitby Esk or southward to the Derwent. The highest hill of this district—Roseberry Topping—lies very near the edge of the plateau.

In Lincolnshire the scarp forms a much narrower feature, running quite north and south, and is often spoken of as the **Lincoln Heights.** Locally it is called "The Cliff." At a river gap cutting the escarpment transversely—from west to east—stands Lincoln. (See fig. 17.) In Northamptonshire, the escarpment-plateau receives the name of the **Northampton** Heights. The Cotswolds rise much higher, and form a fine series of plateau-wolds, sloping gently towards the Thames Valley. The Cherwell, Windrush, Evenlode, and Coln all drain down the dip-slope towards the next

Clay vale, to join the Thames in the neighbourhood of Oxford.[1]

The Jurassic plateau-escarpment is famous for its sheep, Cleveland and the Cotswolds being well-known regions. Building stone, which is easily worked and yet fairly durable, is obtained from several localities—Portland, Bath, Ketton, and Ancaster having furnished enormous quantities. Iron-

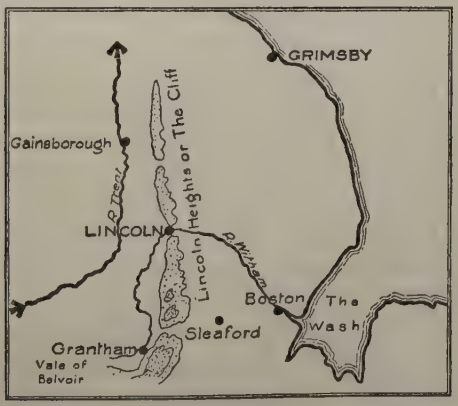


FIG. 17.—THE RELATION OF THE RIVER WITHAM TO THE LINCOLN HEIGHTS OR "THE CLIFF" AT LINCOLN.

Land over 200 feet is lightly stippled; over 300 feet more closely stippled.

ore is obtained from the Jurassic rocks of Cleveland, Lincolnshire, Leicestershire, Northamptonshire, and Oxfordshire.

The third belt is a second Clay vale, occupied by clays of the Upper Jurassic and Lower Cretaceous. This Clay vale is well developed in Yorkshire, where as the **Vale of Pickering** it extends east and west between the Jurassic North York Moors and the Chalk Yorkshire Wolds. In Lincolnshire it forms a narrow vale running north and south between the Lincoln Heights and the Lincoln Wolds. South of this it forms part of the **Fenlands** of the Wash. From here the Clay

[1] They are sometimes known as "consequent streams."

Vale runs from north-east to south-west, and is known in the middle part as the **Vale of Aylesbury.** It lies *between* the Chalk Escarpment and the Jurassic Escarpment. Cambridge, Bedford, Aylesbury, and Oxford are old English towns in this Clay Vale. The sluggish Great Ouse drains it north-eastward to the Wash, and the Thame south-westward to the Thames. Farther south-west still is the **Vale of the White Horse,** lying between the White Horse Hills and the Cotswolds. The Great Western main line from Didcot Junction to the west runs along this part of the Clay Vale.

The fourth belt is the series of Chalk scarps which run roughly parallel to the Jurassic Limestone hills from **Flamborough Head** to the White Horse Hills mentioned in the last paragraph. In Yorkshire the Chalk Wolds curve round from the cliffs of Flamborough Head and Bempton—Bridlington, Driffield, and Beverley being just inside the curve of the Wolds themselves. In Lincolnshire the Chalk belt forms the Wolds of that county, running almost due north and south. Then the Chalk is cut out by the Wash, to reappear in the cliffs of Hunstanton. The **East Anglian "Heights"** of Norfolk and Suffolk pass into the **Gog-Magog Hills** of Cambridgeshire, from which the transition is gradual to the higher **Chiltern Hills** of Hertfordshire and Buckinghamshire. The Chilterns lie from north-east to south-west, the scarp edge facing north-west and the gentle dip-slope gradually ending at Hertford, Hatfield, St Albans, Watford, and Rickmansworth. The fine Upland "downs" of Chalk are well seen near Luton, Dunstable, High Wycombe, and Chesham. Combe Hill, 850 feet high, near Princes Risborough, is one of the most conspicuous parts of the escarpment. Near Tring the Chalk Downs rise to slightly over 800 feet.

The Chilterns end in the **Goring Gap,** where the Thames cuts transversely through the Chalk from the Oxford Clay Vale behind. From Wallingford past Goring and Streatley to Whitchurch and Mapledurham, the river winds through a

gap cut in the Chalk Downs. Beyond the gap on the west the Chalk hills continue as the **Berkshire Downs** and the White Horse Hills, still overlooking the Clay Vale. The escarpment here runs more nearly east to west, and the dip-slope is almost due south towards the **Vales of Newbury** and **Pewsey,** through both of which runs the Great Western new main line, from Reading through Westbury to Taunton. Marlborough stands at the southern end of the " Downs " of that name—at the intersection of a fine series of roads, but it is now outside the stream of modern traffic, as no *main* line of railway touches it. The Chalk Escarpment has been traced from Yorkshire through Lincolnshire, Norfolk and Suffolk, Bedford and Hertfordshire, Buckinghamshire and Oxfordshire, to Berkshire and North Wiltshire. The features are much the same throughout—rolling " downs," with rather short grass and comparatively few trees, largely given over to sheep in the higher parts, but often well cultivated on the lower parts of the dip-slopes.

The sheep of the Yorkshire Wolds, the Lincoln Wolds, the Chilterns, and the Berkshire Downs have long yielded much excellent wool, and it was no accident that Jack of Newbury instituted his early woollen manufacture in the time of Queen Elizabeth, using the wool of these downs. Newbury, Marlborough, and Savernake were then great sheep-markets.

The Wessex Downs.—As explained already, this name is here applied to the Chalk Downs which occupy a considerable portion of the counties of Wiltshire, Dorsetshire, and Hampshire. In the south of Wiltshire, **Salisbury Plain** or Plateau is perhaps the best-known part of this natural division of England. This is an undulating plateau on which relics of Tertiary Sandstone—which formation once covered the plateau—have been used to form famous monuments such as **Stonehenge.** Winklebury Hill in the far south of Wiltshire is one of a series of Chalk " hills." Here is Cranborne Chase, from which Chalk uplands extend southwards and south-

westward through Dorsetshire to Dorchester. These hills are often spoken of as the Western Downs. The western fringe of these uplands is formed by sandy beds which underlie the Chalk, and in the neighbourhood of Shaftesbury and Beaminster the plateau ends somewhat sharply against a diversified country of sands and clays. From the eastern border of Wiltshire the Chalk extends as an undulating plain

FIG. 18.—GEOLOGICAL MAP OF THE WEALD.

Key.—6a. Lower Cretaceous Rocks, including Wealden Beds. 6b. Chalk. 7. Tertiary Beds of London and Hampshire Basins.

through Andover, Whitchurch, and Basingstoke on the one hand, and to near Winchester on the other. This part of the Chalk country is often spoken of as the **Hampshire Downs.**

The low arch of Chalk which forms the **Wessex Downs** is not everywhere symmetrical; it is thrown into sharper local folds here and there. Local upfolds of limestone rocks are often readily eroded, the summit is worn off, and the underlying strata are exposed. Such a local upfold has been worn through, and the underlying sands and clays exposed, in the **Vale of Pewsey,** through which runs the new main line of the Great Western Railway to Taunton. A similar small local

bay of older strata appears in the **Vale of Wardour,** the apex of which lies a few miles west of Salisbury. One of the main lines of the Southern Railway, from Salisbury to Axminster and Exeter, uses this vale. These vales of Pewsey and Wardour are small editions of the greater **Weald,** which is dealt with later.

The Wessex Downs are everywhere thinly peopled, and are as a rule scantily wooded, the associated woodland belts occurring chiefly on the rims of clay and sands, especially in such inlets as the Vale of Wardour.

From the numerous monuments found on the Wessex Downs, it is clear that prehistoric man frequented them in considerable numbers. After early British and Roman times, Wessex finally became the strongest of the Anglo-Saxon kingdoms, and eventually dominated the whole country. Winchester was thus the early capital, and is specially associated in history with Alfred, the greatest Wessex king. Another city also famous in history is Salisbury, situated near the junction of a number of small rivers which drain the Chalk plateau.

FIG. 19.—SECTION THROUGH THE NORTH DOWNS AND THE SOUTH DOWNS AND THE WEALD FOREST.

The South-Eastern Angle. — This includes most of the counties of Surrey, Sussex, and Kent. The features of the region are the Chalk North and South Downs, with the Weald country between them. (See fig. 18.) The **North Downs** rise gently from the London Basin to a height of 860 feet, and

a scarp faces south, overlooking a Clay vale. Through this line of scarped hills there are gaps through which the Wey, Mole, Darent, and Medway flow to the Thames. Through these gaps roads of great importance pass from the London Basin to the Weald forest land. At the end of these gaps stand important towns, of which Guildford, Maidstone, and Canterbury are the chief. One of the finest views of rural England is to be had from the top of the Downs, looking southward. The well-wooded **Weald** country, with the red tiles of the country houses and the pretty Kent and Surrey villages, stretches in front of the spectator. The Weald Forest Hills are next seen roughly parallel to the Downs and rising to 800 feet. Beyond these a second Clay vale runs east and west, and lastly, south of it are the **South Downs,** with the gaps of the Arun, Adur, and Ouse corresponding to the Wey, Mole, and Medway gaps through the North Downs. The South Downs terminate eastward in the fine cape, **Beachy Head.**

The North Downs and South Downs reproduce most of the characteristics of the Chilterns. Widespread downs of short grass, with scattered copses of trees, extend for miles, and provide magnificent "lungs" for the vast population of London. The wooded Forest Hills of the Weald formerly yielded large supplies of iron-ore, the smelting being done by charcoal derived from the wood which was then plentiful. The iron-ore is by no means exhausted, but, as a result of the Industrial Revolution, the industry left the region to be located on or near the coal-fields. Now that the deep borings for coal near Dover are yielding large quantities, we may see a revived iron industry in the rural lands of the Weald.

These counties provide some of the best fruit lands of England, apples, pears, and plums being grown in immense quantities. Strawberries are grown in the three counties, but more especially in Kent. Hops are grown in Kent, and in adjoining parts of Surrey and Sussex. Market gardens thrive

owing to the nearness of the great London markets. The Downs are famous sheep-rearing regions, the South Downs having given a name to a famous breed of sheep.

The Tertiary Basins.—In two regions of England the Chalk downfolds are more or less filled with various Tertiary deposits, and these "basins" form well-defined geographical units. These are (1) the London and East Anglia Tertiary region, generally known as the London Basin, and (2) the Hampshire Basin.

The London Basin (see map, fig. 16).—This forms a triangular patch on the map, the apex of the triangle being near Newbury in the Vale of Kennet. The long side of the triangle extends from thence to Cromer in North Norfolk; and a second side is represented by a line drawn from Newbury along the northern slope of the North Downs to the eastern limits of Kent. Between these two diverging lines the London Basin lies, deeply and widely penetrated by the Thames estuary in the south, and by smaller estuaries in Essex and Suffolk. The rocks are clays, sands, and gravels, the best-known formation being the London Clay, which underlies so much of London and the immediate neighbourhood. Some of the sands and gravels are well seen on the "**heaths**" near London, such as Hampstead Heath, Bagshot Heath, and Blackheath. In Norfolk, Suffolk, and North Essex almost the whole region is thickly mantled with boulder clay, and glacial sands and gravels.

The coasts of such a region are generally low, or, if cliffs exist, they are readily eroded by the sea, and the coastal outline suffers rapid change. The coast of North-East Norfolk has long been famous for the changes which are taking place. In the neighbourhood of Sheringham, West Runton, Cromer, and Trimingham, the cliffs disappear at an alarming rate. On the other hand, farther south the tidal drift and currents sweep the material along the coast to be re-deposited. The famous "**Broads**" of Norfolk, which are among the more

striking features of this region, have probably been formed in this way. The rivers Bure, Waveney, and Yare come down from the very low East Anglian Heights of Chalk, from an elevation of little more than 200 feet. They thus flow sluggishly down the dip-slope of the Chalk and across the Tertiary lands. The old estuary or estuaries have consequently been closed at the mouth by the material drifted from the north, and shallow overflow lakes have been formed. These " Broads " are slowly being silted up by debris from farther inland, and by the accumulation of decayed aquatic vegetation. Farther south, **Orford Ness** has been formed as a barrier to the outflow of the river Alde, which has been deflected many miles to the south since mediæval times. (See fig. 44.) The old town of Aldeburgh is now at least ten miles from the present opening of the river. Continuing southward, the estuaries of the Orwell, Stour, Chelmer, and Colne are wide, very shallow openings, which at low tide appear as immense stretches of sand with small streams meandering through them. In the widest estuary—that of the **Thames**—many remarkable changes have been witnessed during historic times : changes of deposit and erosion. Former channels have been filled up by deposits on the one hand ; erosion has cleared away former lands in other districts, especially on the more exposed parts of the outer coast.

It has been pointed out already that this Tertiary region is generally very fertile, and, as the climate is favourable, this is the best wheat region in the British Isles. Before the rapid fall in the price of wheat in the later years of the last century, Essex, Suffolk, and Norfolk produced enormous quantities. Even yet Essex has large areas under wheat ; other crops are barley, peas, beans, potatoes, and turnips. Much fruit is also grown, and market gardening is profitable because of the nearness of the great London markets.

Norwich, Ipswich, Colchester, Chelmsford, and London are towns in this Tertiary region at or near the head of

estuaries. The Norwich estuary has been completely silted up within the last thousand years. Ipswich, Colchester, and Chelmsford stand at the inner limits of shallow estuaries; London, at the inner end of the wide estuary of the Thames, where the unusually high tides add to the facilities which the river offers for an immense trade. London, as a town, as a port, as a national centre, and as a clearing-house for the world, will receive special treatment in a subsequent chapter.

The Hampshire Basin (see map, fig. 16).—This basin, almost confined to Hampshire, also lies in a shallow downfold of the Chalk. Its Tertiary deposits are sands, gravels, clays, and some freshwater limestones. There is no boulder clay, as the Hampshire Basin is outside the glaciated part of Britain. The rocks furnish a fertile subsoil, and this region bears rich crops and possesses fine woodlands.

In some respects the Frome and the sea-arms—the Solent and Spithead—correspond to the Thames and its estuary, and the Avon and the Itchen to the rivers Colne and Lea. Winchester was the capital of the earliest "England," and we always associate with it Alfred, the greatest Anglo-Saxon king. It remained an important ecclesiastical city, but the Norman capital had all the advantages of a great port, and fulfilled the functions of both Winchester and Southampton. Hence London left the old capital far behind. The only other great towns of the Hampshire Basin are Southampton and Portsmouth, the latter being actually the greatest in population. Bournemouth is the only other considerable town.

The English Fen-Lands.—There are three chief localities where denudation or depression, or both, followed by redeposition, have given rise to considerable areas at tidal level, and where broad stretches of fen-land existed before modern drainage operations reclaimed large portions of them. These are:—(*a*) the Fen-lands of the Wash; (*b*) the Fen-lands of the Humber and Yorkshire Ouse; (*c*) the Fen-lands of Somersetshire. In each case there has been considerable

formation of decayed aquatic vegetation—the fen-peat of the geologist. The rivers flow sluggishly, through channels which have become well " dyked " in the course of ages. Low, flat meadows have been drained as completely as possible, and good land for agriculture obtained from the reclaimed fens. In this way, orchards, market gardens, fields of peas and beans occupy considerable portions of what were in early mediæval times the homes of lost causes, the refuge of persecuted monks or of fugitive princes.

Bits of older strata—harder and firmer—stand up like islands in the land of morasses, and as " islands " they have indeed been known and become famous. It is only necessary to mention the **Isle of Ely** in the swamps of the Wash, the **Isle of Axholme** in the Humber fens, and the **Isle of Athelney** amid the Somersetshire morasses. Each of these has left its mark on the history of the country. With the mention of these Fen-lands—regions filled by the deposits of quite recent geological age—we bring to a close our regional review of Great Britain. The structure of Ireland must now be summarised in the same way.

CHAPTER V

THE STRUCTURE OF THE BRITISH ISLES—NATURAL REGIONS (*contd.*)

IRELAND

IRELAND is an outlier of Great Britain, and is in most respects a summary of the different regional types found in the larger island. There is no physical division in Ireland which has not its counterpart in Great Britain, and every Irish region is a continuation of a similar one across the narrow seas. The following natural regions may be recognised in fig. 20:—

1. The Caledonian North-West.
2. The Antrim Plateau.
3. The Mourne Mountains and Newry.
4. The Wicklow Hills.
5. The Carboniferous Limestone Central Plain.
6. The Armorican South and South-West.

1. **The Caledonian North-West.**—This is a continuation of the Highlands of Scotland. The same metamorphic rocks—schists and gneisses—and the same granite masses occur. The coasts are of the same type; the cliffs of contorted rocks are indented with true fiords, and are among the finest in the British Isles. The surface, too, is the same, infertile generally; and the region is alike sparsely peopled. The **Donegal Mountains** are similar in build to the mountains in the Highlands of Scotland, but they are not quite so high. Gweebarrow, rising to nearly 2500 feet, is a quartzite mass similar to

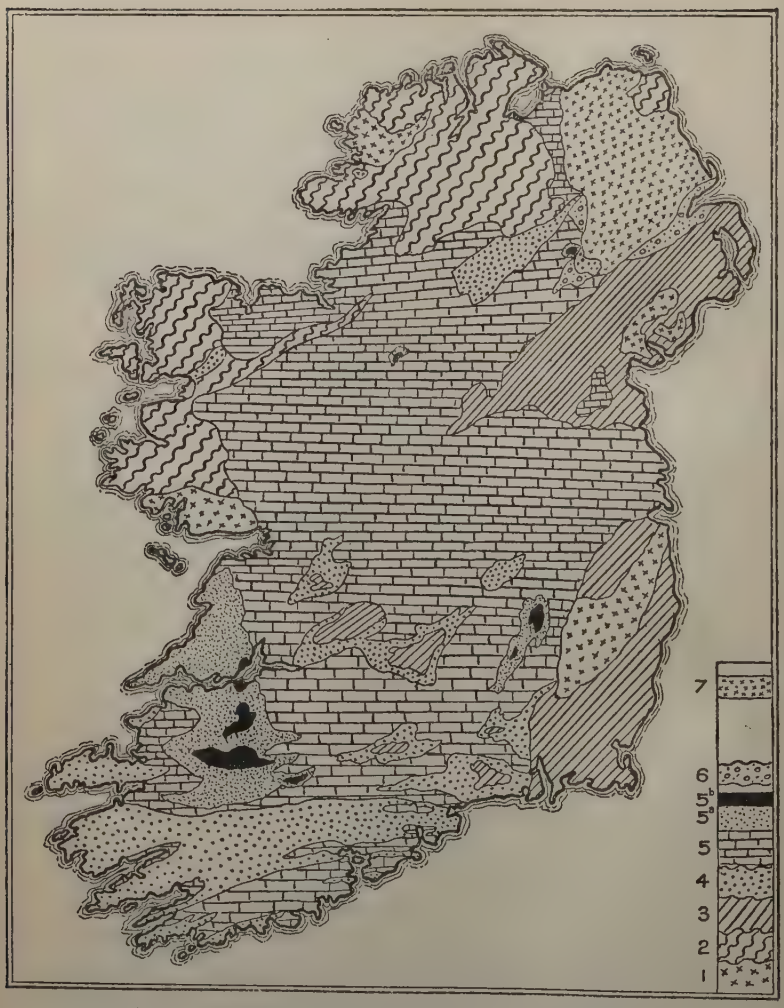


FIG. 20.—SIMPLIFIED GEOLOGICAL MAP OF IRELAND.

Key.—1. Granite Masses. 2. Archæan and Metamorphic. 3. Lower Palæozoic. 4. Devonian (Old Red Sandstone). 5. Carboniferous Limestone. 5^a. Millstone Grit. 5^b. Coal Measures. 6. New Red Sandstone. 7. Tertiary Volcanic Rocks.

many a mountain in Sutherland. Blue Stack is a fine peak of granite and metamorphic rocks rising to over 2200 feet; Errigal is nearly 2500 feet high.

2. **The Antrim Plateau.**—This consists mainly of Tertiary lavas with Carboniferous and other rocks showing themselves under the edges of the volcanic covering. Because of these different rocks the Antrim coast is one of the most varied, possibly *the* most varied, in the British Isles, and from Belfast to Lough Foyle there is one wonderful succession of changing coastal features. The far-famed basaltic pillars of **Giant's Causeway** are the same in character and age as those of the Isle of Staffa. The whole of the volcanic rocks are in the same province as the volcanic rocks of Skye and Mull, Rum and Eigg and Staffa. The interior is comparatively monotonous, except in a few places where the rivers have cut down into the plateau so far as to expose some of the underlying rocks. Glenariff, famous for its waterfalls and pot-holes, is one of the glens of that type. Iron-ore is obtained from the igneous rocks of Antrim, where it occurs interbedded among the extensive lava-flows. Bauxite, an ore of aluminium, also occurs in connection with the volcanic rocks. Rock salt is obtained from the New Red Sandstone near Larne.

3. **The Mourne Mountains and Newry.**—This is a region of very old slates, grits, and other rocks, a continuation in Ireland of the Southern Uplands of Scotland. The granites of Criffel and Loch Doon in Scotland have their counterpart in the beautiful granites of the **Mourne Mountains.** Slieve Donard, 2800 feet high, the highest mountain in N.E. Ireland, is due to one of these granite masses. The Mourne Mountains are suited to sheep farming, just as are the corresponding Southern Uplands of Scotland.

4. **The Wicklow Region.**—This corresponds to Central and North Wales, and consists of rocks similar to those across the Irish Sea and St George's Channel. The one point of individuality about the **Wicklow Hills** is the occurrence of the

greatest mass of granite in the British Isles, the well-known **Leinster Granite**, which extends from the N.E. to the S.W. across the Wicklow region. Famous among the peaks of this hill-region are Lugnaquilla, over 3000 feet high, and Sugar Loaf, a little less than 1700 feet. This is a region of bold mountains, beautiful glens, and small, picturesque loughs, and has been called the "Garden of Ireland." Gold has been obtained near the junction of the granite with the other rocks in the northern Wicklows. This may be compared with the Merioneth gold-mine in Wales. Copper and tin ores are also found in the Wicklows, whilst silver-lead mines near Glendalough remind us of the similar areas in the Southern Uplands, the Isle of Man, and North Wales.

The student will not have failed to notice the general similarity of the regions of old rocks which lie round the Irish Sea. These are the Southern Uplands of Scotland, the English Lake District, North and Central Wales, the Wicklow Hills, and the Mourne Mountains and Newry region. To these may be added the **Isle of Man,** from the highest point of which, **Snaefell,** it is said the observer may see the hills of all these surrounding regions on a clear day. These six regions (including the Isle of Man) are remarkable for their general likeness of structure and for the general similarity of their resources and industries. The differences are due mainly to the igneous rocks interspersed among the slates, grits, and limestones.

5. **The Central Plain.**—The Carboniferous Limestone of the English Pennines and North Wales opens out in Central Ireland into wide, shallow downfolds. The land is low-lying —seldom more than 300 feet above sea-level—and from the hill-regions there has been carried into the shallow basins the material worn from the older rocks. In the Glacial Period the glaciers from the hills descended into this lowland, re-sorted the debris of ages, and added to it the fine rock-material of the moraines. Possibly most of the remaining Coal

Measures were then worn away and the Carboniferous Limestone left exposed.

After the Glacial Period aquatic vegetation flourished in the water-logged plain. The famous **peat-bogs** are the result

FIG. 21.—GEOLOGICAL MAP OF THE UPLAND AREAS OF LOWER PALÆOZOIC ROCKS ROUND THE IRISH SEA, WITH THE UPLAND PART OF THE ISLE OF MAN IN THE MIDDLE.

(See also figs. 4, 7, 8, 11, 12, 13, 20.)

of the long-continued accumulation and decay of plants in the shallow pools and swampy lowlands. The rivers widen out into irregular lakes with many grass-grown islands. The **Shannon** expands into Lakes Allen, Ree, and Derg. The waters contain weak acids which give them considerable solvent power, and the solution of the underlying limestone follows. This is no doubt the primary cause of the lakes,

though the presence of impervious boulder clay which will dam up the water is another important factor.

The plain is by no means all swamp-covered, and the bogs are restricted to certain areas. The Carboniferous Limestone and the older rocks frequently stand up above the general low level. In some parts of the plain there are considerable patches of Millstone Grit and Coal Measures. The coal of the latter is often anthracite, but, owing to the fragmentary and scattered nature of the Coal Measures, is not large in amount. Ireland seldom produces more than 100,000 tons of coal in a year. In 1933, out of a total of 208,000,000 tons for the British Isles, only 90,000 tons, an almost neglibible quantity, were raised in Ireland.

Many parts of the Central Plain are fertile, the Carboniferous Limestone and the varied surface deposits yielding fertile soils. Hence there is some of the best pasture land in the British Isles, and towards the east, where the rainfall is less, the production of oats and barley is possible.

6. **The Armorican South and South-West of Ireland.**— The rocks in this region are Old Red Sandstone and Carboniferous. They have been thrown into sharp folds with a general east-and-west direction. These folds belong to a series of earth-movements which have affected much of Western Europe. One of the most important regions to be thus affected is Brittany ; hence the movements have been called Armorican, from the Roman name for that region. This system of folds affects the rocks of Brittany, the Cotentin, the Mendips, South Wales, and the south of Ireland. In the last-named region the folds are finely developed, and the correspondence of downfolds with valleys is remarkably close. The Carboniferous Limestone frequently lies in the downfolds with Old Red Sandstone on either side. The rivers Blackwater, Lee, and Bandon flow for some distance as longitudinal streams along the axis of these downfolds, then they cut through the intervening rocks in transverse gorges, at

right angles to their former courses. In the far south-west of Ireland the sinking of the whole region has allowed the sea to penetrate the valleys, and the **rias** of that region thus occur in the downfolds of the rocks. South of the Shannon there are seven parallel promontories :—Kerry Head, Dingle Peninsula, Cahersiveen Peninsula, Crow Head Peninsula, Sheep Head, Mizen Head, and the promontory from which Cape Clear Island is a detached part. There will obviously be at least six of the ria-like bays between them ; these are Tralee Bay, Dingle Bay, Kenmare River, Bantry Bay, Dunmanus Bay, and the wide complex opening containing Crookhaven and Skibbereen Bay.

The Old Red Sandstone here occurs in the highest mountains in Ireland. The **M'Gillycuddy's Reeks** rise to over 3400 feet in Carrantual, the highest peak. Brandon Hill, on Dingle Promontory, is another Old Red Sandstone mountain, rising to over 3000 feet. The famous Lakes of **Killarney** lie near the junction of the Old Red Sandstone and the Carboniferous Limestone.

Few minerals are obtained from this region, though copper ore has been obtained from the Carboniferous Limestone near the Lakes of Killarney. The Limestone is quarried at several places, and is polished for marble in a few localities. The " red marble " of Cork is well known.

With this study of Ireland we conclude our review of the Natural Regions of the British Isles.

CHAPTER VI

THE RIVERS AND LAKES OF BRITAIN

It is obvious that there can be no long rivers in the British Isles ; the Thames, the Severn, and the Shannon, the longest of them, are each little more than 200 miles in length. In spite of their short courses, the British rivers are both interesting and important. In consequence of the number of mountain groups and ranges, and the regular and sufficient rainfall, rivers are very numerous, and their valleys or basins reveal much charm of scenery. In this lies much of their interest.

We have already seen that the mountains lie, on the whole, near the western coasts ; the rivers which flow to the east are, therefore, longer and flow more slowly than those which flow directly to the western seas. Even in this, however, there is great variation, due to the irregular build of the land. The rivers of Great Britain will be studied in regional groups ; and the rivers of Ireland will be studied separately.

The Rivers of the Northern Highlands.—Those rivers which flow westward to the Minch and the Atlantic are short, very numerous, and torrential. The watershed runs in an irregular line from Cape Wrath to the Forest of Moydart, keeping near the western coast. The rainfall is heavy, and the rivers, therefore, race to the sea, or into inland lochs and sea-lochs of wild, romantic beauty. The second group is that series of much longer eastward-flowing rivers, of which Helmsdale, Brora, Oykell, Carron, Conan, and Beauly are the most important. These flow across the old Caledonian

plateau, through many a long, narrow glen-loch, and over many rapids and waterfalls. Before reaching the North Sea or the eastern gulfs, they cross a belt of Old Red Sandstone, and through this many of them have cut gorges of great beauty, such as the famous **Allt Graat,** near Cromarty Firth, which is over 100 feet deep, and in the narrowest part is only 17 feet wide at the top. The third group of Northern Highland rivers includes those which flow to the northern sea ; of these

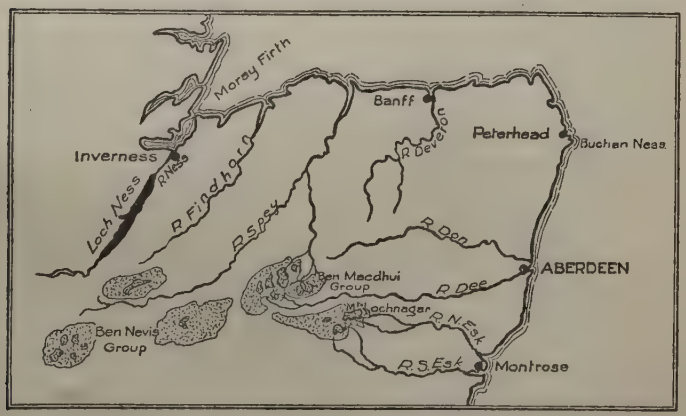


FIG. 22.—RIVERS OF THE N.E. HIGHLANDS OF SCOTLAND AND THE POSITION OF SOME OF THE CHIEF MOUNTAIN MASSES.

Thurso, Halladale, and Navar may be mentioned. All the Northern Highland rivers offer endless possibilities of water power ; but the region is so far removed from the present centres of population, and the soil of the region is so infertile that it seems doubtful if it can be developed as an industrial region. The rivers seem likely to remain, as they are at present, of greatest interest to the angler, the tourist, the artist, and the naturalist.

The Rivers of the Grampians.—These are longer and more important. Four follow the grain of the region and flow on the whole from S.W. to N.E. (See fig. 22.) The **Ness** drains the

long, narrow lake of the same name to the Moray Firth; Inverness stands at its mouth. The **Findhorn** rises in the Monadliath Mountains, flows across the dissected Highland plateau, and through a fine gorge in the Old Red Sandstone coastal strip. The **Spey** is a much longer river, which rises near the Great Glen. After flowing eastward for some distance, it turns towards the north-east and follows the grain of the country. Leaving the great mass of the Cairngorm Mountains to the right, and flowing through a narrow valley, it receives the Avon from the group of mountains just mentioned. The **Deveron** is a much more irregular Highland stream, which flows by turns eastward and northward, its general direction being parallel to that of the Findhorn and Spey.

The **Don** and the **Dee** are rivers of the Eastern Highlands which flow from the heart of the Grampians to enter the North Sea not far from each other near Aberdeen. The Dee is famous for its beautiful scenery and for its bracing climate. The riverside resorts of Ballater and Braemar are in the rain-shadow of the Cairngorm group and Lochnagar mountain. The Linns of Dee are rapids, rock-pools, and gorges worn by the river in the Highland schists.

The two **Esks, North and South,** rise on the eastern and southern flanks of Mount Lochnagar, and flow across the Braes of Angus. Leaving the true Highlands, they cut across the "foot-hills" of Old Red Sandstone, and fine gorges are formed in the well-jointed rocks of that system.

The Tay; the Forth; the Clyde.—The upper Tay collects a number of Highland streams; the lower Tay is a typical river of the lowlands. It rises in Ben Lui, and for a short distance runs to the north-east; then it bends sharply and flows through Strath Fillan to Crianlarich, where the Caledonian Railway line to Oban and the North British Railway route to Fort William cross each other. From Crianlarich it flows through Glen Dochart to the north-east, parallel to the Great Glen, the Spey, and the main structure-lines of the

Highlands. It passes through **Loch Tay,** a long, narrow lake which occupies about one-third of that stretch of the river. Some miles south of Pitlochry it is joined by its great tributary, the **Tummel**, and at the confluence it turns almost at right angles, and soon leaves the Highlands at Dunkeld. (See fig. 23.)

The Tummel drains Loch Rannoch, and is joined by the

FIG. 23.—THE TAY AND THE FORTH, WITH THEIR CHIEF TRIBUTARIES.

The mountain masses are shown diagrammatically by stippling. (Compare with figs. 3 and 4.)

Garry from the Pass of Killiecrankie. Fine waterfalls occur both on the Garry and its tributary mountain streams. On emerging from the Highlands the Tay crosses the Old Red Sandstone of Strathmore; here it is joined by the Isla from the north-east, and the main stream takes the direction of the tributary for some distance. One of the tributaries of the Isla—the Ericht—forms a fine gorge in the Old Red Sandstone not far from Blairgowrie. The Tay now flows across the plain southward and then south-eastward, passing Perth on the

way. Just after opening out into its great estuary it receives the **Earn,** an important right-bank tributary. The united river is said to carry down into the North Sea more water than any other British river.

The **Forth** flows for some distance across the Highlands, which it leaves at Aberfoyle.[1] Its tributary, the **Teith,** which drains Loch Katrine and the far-famed **Trossachs,** has a similar course. The combined river flows through a lowland "gate" between the Ochil Hills and Campsie Fells and passes Stirling. In this part of its course the river meanders a good deal, and the windings between Stirling and Alloa are often called the Links of Forth. In the neighbourhood of the latter town the Forth widens out into one of the largest of British estuaries. (See fig. 23.)

It will be convenient at this point to discuss the **Clyde.** This river rises in the Lowther Hills in the middle of the Southern Uplands. It crosses the boundary fault (pp. 6 and 22), passes the Tinto Hills, and then forms the well-known Cora Linn or the **Falls of Clyde.** Here the Clyde has cut a fine gorge in the Old Red Sandstone. Near Lanark a tributary, the **Mouse Water,** joins the Clyde, and this also runs through a deep, narrow gorge. After the confluence the Clyde still cuts through a gorge, but soon opens out into a wide valley as it reaches the Lanarkshire coal-field. It passes Glasgow and empties itself into a ria-like estuary, with the Campsie Fells on the right and the low Renfrew Heights on the left.

The Rivers of the Southern Uplands (see map, fig. 7). —The **Tweed** is the chief river of the Southern Uplands. Beginning in Hartfell, not far from the head-waters of the Clyde, it first flows to the north-east, and in the neighbourhood of Peebles flows due east. Here it receives on the left Gala Water, which flows past Galashiels. Before this it receives the **Ettrick** from the right. This tributary flows from the moorland region between Hartfell and Ettrick Pen, two typical

[1] Aber = Gaelic for "mouth of."

hills of the Southern Uplands. The Tweed continues its eastward course past Melrose, soon after which it receives the **Teviot,** a river which runs roughly parallel to the Ettrick. At Kelso, not far from the confluence with the Teviot, the main stream takes the course of its tributary and flows north-east through "The Merse," to the North Sea at Berwick. In the latter part of its course it receives the **Till,** a river which drains the north-eastern region of the Cheviots, and the combined waters of the Blackadder and Whiteadder. The Tweed is famous for its scenery, which is quite different in type from that of the Highlands. The rounded outlines of the hills, covered with grass, bracken, or heather, and the verdure of the alluvial flats of the Tweed and its tributaries, make of the river and the uplands a charming combination.

The Tweed region is also famous in Border history and romance; and it will for ever be associated with the name of Scott, who did so much to make it famous. The London and North-Eastern Railway route from Carlisle to Edinburgh uses in turn the valleys of the Teviot, the Tweed, and the Gala Water, and is very fittingly called the Waverley Route.

The rivers of the western part of the Southern Uplands are the Dee, Nith, Annan, and Esk. (See fig. 24.) The **Dee** rises in Mount Merrick, the highest mountain in the Southern Uplands; it is joined by the river **Ken,** which has its sources in Black Larg and which flows through Loch Ken. The combined waters of the Dee and the Ken widen out to form **Loch Dee,** which is so well seen on the impressive railway journey from Castle Douglas westward. The **Nith** flows along a New Red Sandstone valley past the town of Dumfries. The Glasgow and South-Western Railway from Carlisle to Glasgow uses Nithsdale as part of its route. The **Annan** rises not far from the sources of the Tweed and the Clyde in the Hartfell group, and flows to the north-eastern corner of the Solway Firth. The Caledonian Railway uses Annandale for its main line from Carlisle to Carstairs, Glasgow, and Edinburgh. The

Esk rises in Ettrick Pen, and is joined by the Liddel from the western Cheviots. This Esk is the one made famous by Scott in his *Young Lochinvar*: "He swam the Esk river where ford there was none." It will be seen from the map that the Dee, Nith, Annan, and Esk are remarkably parallel in their general direction towards the Solway. In a sense they are all tribu-

FIG. 24.—RIVERS OF THE SOLWAY AND THE UPLANDS FROM WHICH THEY FLOW.

Land over 600 feet lightly stippled; over 1200 feet closely stippled.

Key.—M., Merrick; H.F., Hartfell; Br., Broadlaw; B.L., Black Larg; E.P., Ettrick Pen; P.F., Peel Fell.

taries of the comparatively small river Liddel, which flows from N.E. to S.W. into the head of Solway Firth.

The Pennine Rivers.—Rivers flow east and west from the Pennine uplift, those of the east being longer than those of the west; that is, the Pennine watershed is nearer the western than the eastern coast. The symmetry of the Pennine rivers is interfered with by the Lake District mountains, the Bowland Fells and Rossendale Fells on the west, and by the hills of East Yorkshire. (See fig. 25.) The Tyne, Wear, and Tees flow independently to the sea; the Swale, Ure, Nidd, Wharfe, Aire

(with the Calder), and Don are collected together as the Yorkshire Ouse. The Ouse and the Trent together make the Humber estuary, which cuts transversely through the Chalk escarpment.

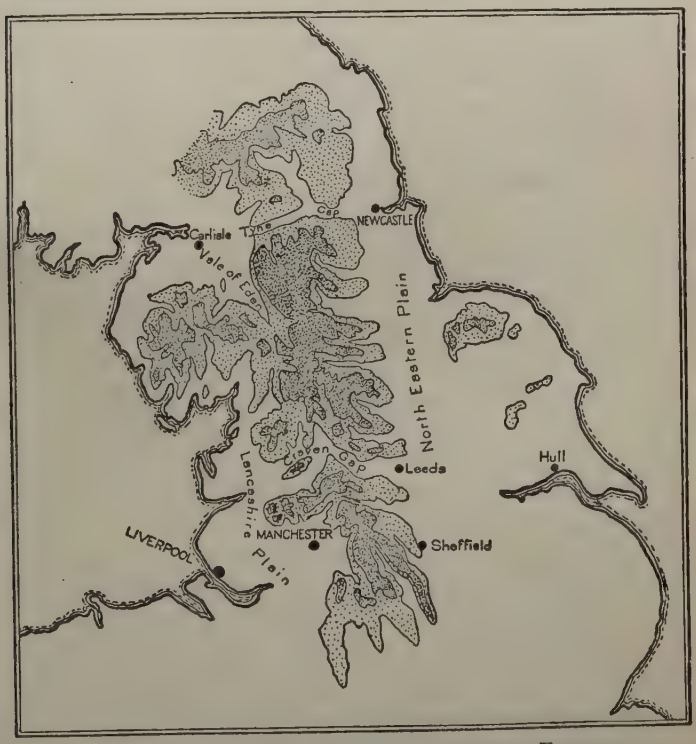


FIG. 25.—OROGRAPHICAL MAP OF NORTHERN ENGLAND.
Showing the Uplands, the gaps, the Lowlands, and the chief river valleys. Land over 600 feet is lightly stippled; over 1200 feet closely stippled.

The **Tyne** is made up of the North Tyne and the South Tyne, the confluence being near Hexham. The North Tyne rises in Peel Fell among the Border Cheviots, and flows south-eastward to its junction with the South Tyne. Its valley is used by the London and North-Eastern Railway line from Hexham, which

crosses the border and meets the Waverley Route at Riccarton Junction. The South Tyne begins in the Cross Fell moorlands, flows northward past Alston, and turns eastward at Haltwhistle to flow through the Tyne Gap to Newcastle.

The **Wear** comes from Kilhope Law and flows slightly south-eastward past St John's Chapel and Stanhope to Bishop Auckland. Here the river turns and runs parallel to the high ground of the Magnesian Limestone. It meanders past the old cathedral city of Durham and Chester-le-Street, to cut through the Magnesian Limestone on its way to the sea at Sunderland.

The **Tees** rises on the southern flanks of Cross Fell and, with its moorland tributaries, drains the eastern slopes of a fine series of fells—Dufton, Murton, Hilton, Burton, and Warcop Fells. It forms two well-known waterfalls, Cauldron Snout and High Force, where it crosses the Whin Sill, an intrusion of basaltic rock. There is very fine scenery in its course near Middleton-in-Teesdale, Barnard Castle, and Rokeby. Its chief tributary is the **Lune,** coming from Stainmoor Forest on the southern side of Mickle Fell to join the Tees near Middleton.

The rivers of the Yorkshire Ouse system come next in order. The **Swale** rises at a height of about 2000 feet in Nine Standards Rigg and Birkdale Common, being made up of a number of peaty, moorland streams. One of these drains Birkdale Tarn, a small lake on the plateau of the Northern Pennines. The upper Swale flows through a limestone gorge at Kisdon, near Keld, and here are the grand Kisdon Falls. At Reeth, Arkle Beck comes in from Arkengarthdale on the left. Richmond stands near the end of the remote and thinly peopled Swaledale, where the river leaves the Pennines for the North-Eastern Plain.

The **Ure** (or **Yore**) begins in the moorlands of Mallerstang, and flows past Hawes and through beautiful Wensleydale. At Bainbridge the river Bain joins it on the right, having

drained Semmer Water, a lonely lake among the moorlands. Near Aysgarth, Bishopsdale Beck also comes in from the right, and at Middleham, a few miles farther, the river Cover from Coverdale joins the Yore. There are many waterfalls in this upper part of Wensleydale, the most famous of them being Hardraw Scar near Hawes, and Aysgarth Force. Ripon stands where the Yore leaves the Pennines and passes on to the New Red Sandstone plain of North Yorkshire.

The **Nidd** rises in Great Whernside, flows through Nidderdale, past Pateley Bridge, and at Knaresborough leaves the Pennines for the plain.

The **Wharfe**—a much longer river—for a time runs along the axis of the Pennines, through beautiful Upper Wharfedale, with limestone scars on either side. The first important tributary is the Skirfare, which rises in Penygent and drains Littondale. The Wharfe passes Grassington, Burnsall, Barden Tower, and Bolton Abbey, and in this stretch of the river the scenery is fine. At Bolton Abbey there are many pot-holes in the grit rocks over which the water flows when in flood, and at one place the peaty river races through "The Strid," a narrow gorge about four feet in width. After Bolton Abbey the river passes Ilkley and Otley, and leaves the Pennines at Wetherby.

From the southern flanks of Fountains Fell a number of peaty streams flow towards Malham Tarn, another of the small natural lakes of the Yorkshire Pennines. The stream which leaves the lake sinks into the limestone very soon and flows underground. At the foot of Malham Cove, a lofty precipice of Carboniferous Limestone, a stream issues which is generally spoken of as the beginning of the **Aire.**[1] Very soon it is joined by Gordale Beck from the grand limestone gorge called Gordale Scar. The river passes Kirkby Malham, Airton, Gargrave, and Skipton, which latter town stands in the middle

[1] Another stream issues from the limestone below Malham village; this is another part source of the Aire.

of the Aire Gap or Craven Gap of the Pennines (see p. 26). It flows past Keighley, Bingley, Saltaire, and Shipley, to Leeds, where it leaves the Pennines. The Aire valley from near Gargrave to Leeds is the route followed by a main line of the London, Midland, and Scottish Railway through the Pennines.

The **Calder** rises in the moors south-east of Burnley. It runs past Todmorden and Hebden Bridge to Sowerby Bridge, through a deeply cut and narrow valley, which is used by the former Lancashire and Yorkshire Railway main line, by the Rochdale Canal, and by a " main road." At Hebden Bridge the Calder receives from the left Hebden Water, a river which has cut a very fine gorge in the Millstone Grit of the moorlands. After Sowerby Bridge it passes Brighouse, Mirfield, Dewsbury, and Wakefield.

At Mirfield it is joined by the river **Colne,** from Colne Valley, in which are Huddersfield and a number of busy manufacturing villages. The Aire and Calder unite at Castleford. Wakefield is the town which corresponds in position with Richmond, Ripon, Knaresborough, Wetherby, and Leeds.

The **Don** is the last of these Pennine feeders of the Yorkshire Ouse. It begins as a number of moorland streams on the north-eastern border of Derbyshire and flows north-eastward. The best-known tributary of the Don is the Sheaf, on which stands Sheffield. Rotherham is the town which corresponds most nearly with the line of towns mentioned above. When the river has reached the plain and is approaching the fen-lands of the Humber it passes Doncaster. Beyond this the alluvial deposits of the Ouse-Trent have covered the New Red Sandstone rocks.

These rivers, Swale, Yore, Nidd, Wharfe, Aire (with Calder), and Don, make up the **Yorkshire Ouse.** Very often the joint waters of the Swale and Yore from near Boroughbridge southward are called the Ouse, and the Nidd, Wharfe, Aire, and Don are regarded as tributaries. There is now the interesting eastern tributary, the **Derwent,** to be considered. This rises

in the North York moors, not far from Robin Hood's Bay. At first it flows south and then slightly south-eastward, as though it would flow to the sea a little north of Scarborough. It turns off through the Vale of Pickering or Vale of Malton, gathers up a number of south-flowing tributaries from the North York moors, flows through a gorge in the Jurassic rocks, and finally meanders southward through the alluvial plain to join the Ouse south of Selby.

The **Trent** has its origin in the high ground on the borders of Cheshire and Staffordshire. It flows south by east past Stoke to the borders of Leicestershire. It then turns eastward and north-eastward past Burton, and, after a long interval, Nottingham, receiving on the way the Pennine rivers **Dove** and **Derwent.** The nature of the course of the Trent here is shown by its popular name, " The Sulky Trent." At Newark the Trent begins to run due north ; it passes Gainsborough, beyond which the tide comes up, and it then joins the Ouse to cut through the Chalk transversely. The breach through the Chalk is clearly seen at Barton on the Lincolnshire side, and a little west of Hull on the Yorkshire side.

The **Dove** begins in the Millstone Grit moorlands of Axe Edge, and, after running through a thinly peopled but very charming dale (Dovedale), passes from the Pennine region on to the Midland Plain at Uttoxeter. One of the tributaries of the Dove—the Manifold—flows for a considerable distance underground in the Carboniferous Limestone. The **Derwent** begins in the Millstone Grit plateau of the Peak in the north of Derbyshire ; it runs south and east by south, through Chatsworth Park, and then past Matlock, where it forms a magnificent gorge in the Carboniferous Limestone ; then on past Cromford, Belper, and Derby to the Trent. The **Wye** rises near Buxton and flows obliquely across the Limestone plateau of Mid-Derbyshire, cutting fine gorges at Buxton, Miller's Dale, and Monsal Dale. The winding gorge at Monsal Dale is one of the grandest in the British Isles. After

passing Bakewell and Haddon Hall, the Wye joins the Derwent at Rowsley.

Important southern tributaries of the Trent are the **Tame** from Birmingham and Tamworth, and the **Soar** from Leicester and Loughborough. These flow across the Midland Plain in sluggish courses.

The rivers of the Pennines which flow to the Irish Sea are the Eden, the Morecambe Bay group, the Ribble, and the Mersey. The **Eden** rises in Mallerstang Forest, in the middle of the Northern Pennines, near the source of the Yore. It flows northward to Kirkby Stephen, its course lying among the great moorland masses of Shunner Fell, Baugh Fell, and Wild Boar Fell. At Kirkby Stephen it passes on to the wedge-shaped area of New Red Sandstone mentioned in Chapter IV. It flows past Appleby and Carlisle on its way to the Solway. Its chief tributaries are the **Eamont,** bringing the drainage of Haweswater and Ulleswater ; the **Caldew,** which drains the northern flanks of Skiddaw, Saddleback, and the Carrock Fell district ; and the **Irthing,** which comes from the western part of the Tyne Gap and joins the Eden on the right.

The **Kent** begins in Shap Fells, passes Kendal, and enters Morecambe Bay at the north-eastern corner. It forms there a considerable estuary, on which are the holiday resorts Arnside, Grange, and Kent's Bank. The **Lune** has its sources on the northern slopes of the Howgill Fells, flows at first due west through Ravenstonedale to Tebay, and then takes a southerly course to Kirkby Lonsdale. Between this town and Lancaster it winds about a good deal, and the well-known " Crook of Lune " is a picturesque part of the winding river. After Lancaster it enters the eastern side of Morecambe Bay. Near Sedbergh it receives on the left the combined waters of the **Rawthey,** the **Clough** from Garsdale, and the **Dee** from beautiful Dentdale. Between Kirkby Lonsdale and Lancaster the **Greta** brings to the Lune the drainage of the pretty dales of Ingleton, and a little later there enters the **Wenning,** which

is made up of Austwick Beck, Clapham Beck, and some streams from the northern part of the Bowland Fells.

The **Wyre** rises in Bleasdale Moor, among the Fells of Bowland Forest, and flows across the Fylde plain to Fleetwood, at the south-western end of Morecambe Bay.

The **Ribble** comes from the Penygent plateau of the Northern Pennines ; it is made up of Gayle Beck and Cam Beck and a number of smaller streams, many of which flow underground for considerable distances in this land of " water-sinks," giant pot-holes, and limestone caverns. It passes Settle, Hellifield, Gisburn, and Clitheroe, and near Whalley Abbey receives the **Lancashire Calder** and the **Hodder.** The former rises close to the Yorkshire Calder, brings the drainage of the Burnley basin to the Ribble, passing Burnley, Padiham, and Whalley on the way. The Hodder drains the southern part of the Bowland Fells, and runs past the old-world village of Slaidburn. After receiving these tributaries, the Ribble passes the old Roman fort at Ribchester, and at the port of Preston opens out into a wide, sandy estuary with Lytham on the north and Southport on the south.

The **Mersey** has only a short course from the western Pennine slopes to the Irish Sea, but, from an industrial point of view, it and its tributaries are exceedingly important. The **Irwell,** its chief northern tributary, rises in the Rossendale Fells, flows through Rossendale and the busy industrial region of South-East Lancashire. It collects the drainage of a number of thickly peopled valleys on the southern slopes of the Rossendale Fells and the western slopes of the Pennines. The chief of these are : the Roche from Rochdale and Littleborough, the Tong from Bolton, the Irk from Royton, Middleton, and the western side of Oldham, and the Medlock from the other side of Oldham. The great dual town Manchester-Salford is on the Irwell, Irk, and Medlock. The Irwell and its tributaries have more works of various kinds on their banks than any river-system of equal size in the world. For part

of its course the Irwell forms a part of the **Manchester Ship Canal.** Another right-bank tributary of the Mersey is the **Tame,** draining the important industrial region of Stalybridge, Dukinfield, Ashton, and Hyde, and joining the main stream at Stockport. The **Weaver** on the left bank collects a number of streams from the western slopes of the Southern Pennines, and flows across the Cheshire Plain.

The combined Mersey system forms a wide estuary with a narrow neck between Liverpool on the one side and Birkenhead-Wallasey on the other. This estuary is one of the busiest in the world. On the Mersey itself, the chief towns are Stockport, Sale, Warrington, Widnes, Runcorn, Liverpool, Bootle, Birkenhead, and Wallasey.

CHAPTER VII

THE RIVERS AND LAKES OF BRITAIN
(*continued*)

The Rivers of the Wash.—Four rivers enter the Wash—the Witham, Welland, Nen, and Great Ouse. The **Witham** is the river of the Kesteven division of Lincolnshire. It rises in the high ground south of Grantham, flows north past that town, and over a plain to Lincoln. Here it suddenly turns eastward, cuts through the escarpment (The Cliff), and then flows over the lowland of the Holland fen, and past Boston to the Wash (see p. 48). A few miles east of Lincoln, while it is still about thirty miles from the sea, it is only 10 feet above sea-level.

The Welland, Nen, and Great Ouse run north-eastward along the grain of the country, and across the Fens. The **Welland** rises in the high ground near Naseby, flows through Rockingham Forest, past Stamford and Spalding to the north-western corner of the Wash. The **Nen** or Nene rises in the western edge of the Northampton Heights, flows past Northampton and Peterborough, and across the Fens to the middle of the Wash. The **Great Ouse** keeps well to the Clay Vale of the Scarplands, and is the most sluggish river of any considerable length in the British Isles. Its sources are west of Buckingham, and it flows in a winding course with a general north-easterly direction past Olney, Bedford, St Neots, Huntingdon, and Ely to King's Lynn and the eastern corner of the Wash. Between Buckingham and Bedford it only falls from about 260 feet to 100 feet; and from Bedford to the sea there is left only this

100 feet of fall. The nature of its course may be judged from the fact that north of Bedford the L.M.S. Railway main line crosses the winding river no less than seven times in a distance

FIG. 26.—RIVERS OF THE WASH, AND THEIR RELATION TO THE LOW UPLANDS OF THE EASTERN MIDLANDS.

of about nine or ten miles. In the later part of its course, where it flows close to the western edge of the Chalk escarpment, it receives the **Cam** and the **Little Ouse.** The former, as the name implies, flows through Cambridge.

The Rivers of East Anglia.—A series of roughly parallel rivers flow down the dip-slopes of the Chalk of Norfolk, Suffolk, and Essex, and across the Tertiary lands to the shallow

North Sea. Of these rivers the chief are the Bure, Yare, Waveney, Orwell, Stour, Colne, and Chelmer. They rise at low elevations—especially the more northern of them—and flow sluggishly across the East Anglian plain. The estuaries of the Bure, Yare, and Waveney have been closed by sand-

FIG. 27.—RIVERS OF EAST ANGLIA.
Showing their relation to the low Chalk Uplands.

dunes, sea-drifted material from the north, and river alluvium; the other rivers still form shallow estuaries, almost useless for modern shipping.

The Thames.—The "basin" of the Thames may readily be separated into two distinct parts—the Inner Thames, with Oxford as the chief town; and the Outer Thames, with London as the focus.

The **Inner Thames** is the part of the river from the Cotswolds

to the Goring Gap. A series of rivers drain the dip-slopes of the Cotswold Hills, and unite to form the Thames. The most southerly river of the series bears the name of **Isis** or **Thames,** and the others are regarded as tributaries. They are all the same in general character however. The most northerly stream is the **Cherwell,** which comes from the borders of Northamptonshire and Warwickshire past Banbury to join

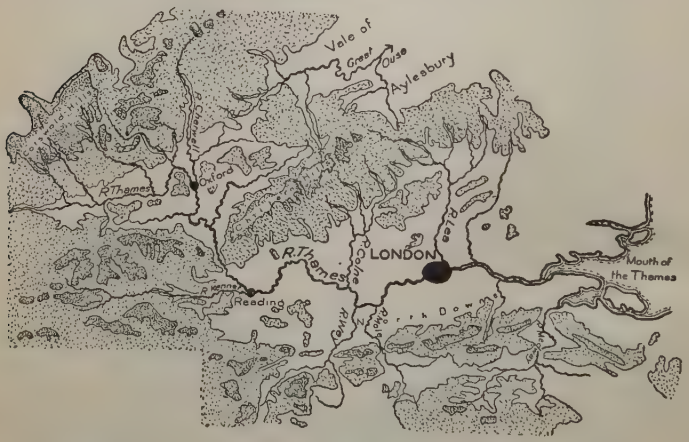


FIG. 28.—THE THAMES AND THE UPLANDS FROM WHICH ITS FEEDERS FLOW.

Land over 300 feet is lightly stippled; over 600 feet closely stippled.

the Thames at Oxford. The other chief streams are the **Coln, Windrush,** and **Evenlode.** The Vale of Oxford in which these streams are gathered together, is a continuation of the Vale of Aylesbury. From Oxford the united Thames flows southward with many windings, receiving two important tributaries. On the right bank is the **Ock,** which has come from the White Horse Hills; later, there comes in on the left bank the **Thame,** which flows from beyond Aylesbury. This river is the counterpart of the Great Ouse in its relation to the Chalk escarpment and in its course along the Clay Vale, but, of course, it flows in the opposite direction. A few miles below

Wallingford the river enters the gap through the Chalk escarpment. In the middle of this gap is the village of Goring, hence it is usually known as the **Goring Gap.** The Thames is here about 100 feet above sea-level; the Chalk downs through which it passes rise to the height of 700 feet not far away. Here the Inner Thames ends.

When the Thames emerges from the gap we may speak of it as the **Outer Thames.** At Reading it receives the **Kennet,** and the united drainage takes the direction of the tributary, that is on the whole eastward. The Kennet comes from the west along the axis of the Vale of Newbury. It rises in the Marlborough Downs, flows southward for a short distance, and then turns eastward through the Tertiary valley past Hungerford and Newbury to its junction with the Thames. From here the Thames flows along the axis of the London Basin, making many large bends, but maintaining a general easterly direction parallel to the trend of the North Downs. It passes Henley, Maidenhead, Windsor, Eton, Staines, Hampton Court, Teddington, Kingston, Twickenham, Richmond, Kew, Brentford, and **London.** Well may it be described as the " Historic Thames " ! The next considerable tributary is the **Colne,** which drains the Chalk slopes west of Dunstable and St Albans, and passes Watford, Rickmansworth, and Uxbridge on its way to the Thames at Staines. At the southern end of a sharp bend of the Thames, the **Wey** enters on the right bank. This river rises in the eastern end of the Hampshire Downs, flows on the whole eastward for a time, then turns north, and cuts through the Hog's Back of the North Downs at Guildford. A short distance after the confluence with the Wey is the junction with the Mole. This comes from the Wealden Forest Hills, flows on the whole northward, cuts through the North Downs at Dorking, and joins the Thames near Hampton Court.

After the Thames has wound its way through London, it receives on the left bank the **Lea,** which, with a number of

tributaries, drains the eastern part of the Chalk slopes of the Chilterns, rising near Luton and flowing south-east to Hatfield, where it turns almost at right angles and runs north-east by Hertford to Ware. After this it turns southward and maintains that direction to the Thames. At Dartford the **Darent** from the North Downs joins the Thames on the right bank. At Rochester, Chatham, and Sheerness the **Medway** joins the wide Thames estuary. This river comes from the Weald Forest, rising not far from Crowborough Beacon; it cuts through the North Downs at Maidstone and Rochester, and opens out into a considerable estuary of its own opposite the Isle of Sheppey. The gaps made by the Wey, Mole, and Medway through the North Downs are most important features. After London, the towns on the Thames are Greenwich, Woolwich, Gravesend, and Sheerness on the south side of the estuary, Tilbury and Southend on the north side.

The English Channel Rivers.—The **Rother** rises in the Forest Hills of the Weald, not far from the source of the Medway; it flows south-eastward to Rye, where its estuary is being silted up by sand at Dungeness. Three rivers of Sussex are similar to the Wey, Mole, and Medway, in making transverse gaps through the Chalk hills; like the northern gaps, these southern ones have been important all through English history. These rivers, the Ouse, Adur, and Arun, all rise in the Weald Forest Hills and flow southward, the **Ouse** past Lewes to Newhaven, the **Arun** past Arundel to Littlehampton.

Southampton Water receives two chief rivers, the **Itchen** and the **Test,** both of which flow from the Chalk uplands of the Hampshire Downs and across the Tertiary basin. The Itchen flows past Winchester, the capital of England a thousand years ago.

The **Avon** of Wessex collects a number of streams which flow across Salisbury Plain; the chief are the Nadder, Wylie,

Winterbourne, Avon, and Bourne. The Winterbourne, like many a river in the Chalk country, is usually dry in the summer. Salisbury stands near the focus of these upland streams. At its mouth the Avon receives from the west the Stour, which flows from the Western Downs past Wimborne. The short **Frome** enters the wide estuary known as Poole Harbour;

FIG. 29.—RIVERS AND UPLANDS OF THE SOUTH-WESTERN PENINSULA.

Land over 600 feet is lightly stippled; over 1200 feet closely stippled.

this river comes from the Jurassic uplands called the Dorset Heights, flows past Dorchester, and then along the axis of a Tertiary basin similar to the Vale of Newbury.

The rivers of Devonshire which flow to the south are Exe, Teign, Dart, Avon, and the Plymouth Sound group. The **Exe** rises in Exmoor Forest in the west of Somersetshire, flows past Tiverton and Exeter to the sea at Exmouth. The **Teign,** the Dart, and the Avon rise in Dartmoor, the great granite moorland of South Devon. The **Dart** is a picturesque river, and the sail upstream from Dartmouth to Totnes

reveals some of the finest scenery in the British Isles. A number of rivers enter Plymouth Sound—the Plym, Tavy, Tamar, and Lynher. The **Tamar** is by far the longest, for it flows almost across the south-western peninsula.

Of the north-flowing rivers of the south-west the longest is the **Torridge,** which rises in the moorlands of Northern Devonshire, flows for a time south-eastward, and then doubles on itself as it receives the Okement, a tributary from the northern slopes of Dartmoor. The Torridge now flows north for the rest of its course, past Torrington, and enters a wide estuary at Bideford. Into the same great bay, called Barnstaple Bay, flows the **Tawe,** which rises in the same part of Dartmoor as the Okement. These two rivers and their estuary played a most important part in the maritime affairs of Britain in Tudor and Stuart times.

Between the Quantock Hills in West Somersetshire and the south-western end of the Cotswolds a number of short parallel streams flow north-westward to the **Bristol Channel.** Of these the most important is the **Parret,** which rises in the Dorset Heights already mentioned, receives the tributary drainage of the **Tane** from the Vale of Taunton, and flows past Bridgewater to the Bristol Channel.

The Severn and its Tributaries.—The Severn is often claimed to be the longest of English rivers. Its course is most interesting. Rising on the eastern slopes of Plinlimmon, it flows east to Newtown, and here alters its course to the north-east. It runs parallel to the axis of the Long Mountain, and then turns sharply to the east again round the northern end of that hill. Here it enters a plain and winds about considerably as it passes Shrewsbury. In this south-eastward course it runs through the gorge between the Wrekin and Wenlock Edge, and continues that direction to Stourport. A little south of this it receives the **Stour,** a stream which drains the western part of the South Staffordshire industrial region, and passes Stourbridge and Kidderminster. The **Severn** now

runs due south past Worcester, having entered the Midland Plain of New Red Sandstone. Below this the **Teme** enters on the right bank, having come from the interesting

FIG. 30.—THE RIVER SEVERN, ITS TRIBUTARIES, AND THE HILLS CONCERNED.

The latter are shown quite diagrammatically, so that the reader will have no difficulty in following the tributaries.

region of the Stiper Stones, the Longmynd, Caer Caradoc, and Wenlock Edge, and having passed historic Ludlow on its way.

At Tewkesbury the **Stratford Avon** enters on the left. This important tributary comes from the very heart of the English Midlands. It begins in South-West Leicestershire,

and meanders over the Midland Plain past Rugby, Leamington, Warwick, and Stratford, beyond which it receives the Stour from the scarp edge of the Cotswolds. The Avon continues its winding course past Evesham to join the Severn at Tewkesbury. The combined stream follows the direction of the Avon south-westward past Gloucester. The river has a winding course in this part of the Severn Gate, and the Berkeley Canal has been cut to avoid the curves. Between the Forest of Dean on the right and the Cotswolds on the left the Severn opens out into a steadily widening estuary. At Chepstow the **Wye** enters on the right. This interesting river begins not far from the source of the Severn. It flows directly south-eastward for a considerable distance until, at the northern end of the Brecknock Hills, it is deflected at right angles to the north-east. It resumes its south-east direction on the borders of Herefordshire, and flows in a meandering course across that county and past the city of Hereford. After passing Symond's Yat it reaches Monmouth, where it receives a right-bank tributary, the Monnow. Then Tintern Abbey and the Wynd Cliff are passed, and the Severn is reached at Chepstow. In the southern part of Herefordshire and in Monmouthshire the river flows through a beautiful, deeply cut valley, and in this part of its course it has been described as the most beautiful river in England; but of course there are many other claimants to that distinction.

Some distance south of the confluence with the Wye, the **Bristol Avon** comes in on the left. This river has a somewhat curious course. It begins in the Cotswolds and flows eastward as a dip-slope stream quite like the young feeders of the Thames. It turns to the south past Chippenham along a narrow extension of the Clay Vale of the Scarp-lands, with the Chalk downs on its eastern and south-eastern side. It now turns sharply towards the north-west past Bradford and cuts transversely through the Cotswolds, passing Bath on the way. In the gap the river is about 100 feet above sea-level; the

Cotswolds in the neighbourhood rise to 700 feet.[1] After leaving the Cotswolds gap the Avon crosses the Bristol coal-field and passes Bristol itself, beyond which it cuts through the Carboniferous Limestone, making the fine Clifton gorge. It now opens out to join the Severn at Avonmouth.

To return to the **Severn**; it receives on the right another important tributary, the **Usk,** which joins it a little south of Newport. This river rises in the Black Mountains of Western Brecknockshire, flows eastward past Brecknock, and then south-eastward to Abergavenny, from which it flows in a winding course southward to Newport.

There is a series of at least fourteen streams flowing across the busiest part of the South Wales coal-field. The Afon is the most easterly and the Llynfi the most westerly of this series. Among them the Ebbw, Rhimney, Taff, and Rhondda are perhaps the best known. The **Taff** rises in the southern slopes of the Brecknock Beacons, and brings to the Severn near **Cardiff** the drainage of five of the streams from the middle of the coal-field. After receiving the Taff on the right, passing Weston-super-Mare on the left, and two small islands of Carboniferous Limestone—Flat Holme and Steep Holme—the Severn may be regarded as ending in the rapidly widening Bristol Channel.

Other Welsh Rivers.—The **Neath,** which enters at Swansea Bay, the **Towy** at Caermarthen, the **Teifi** at Cardigan, the **Mawddach** at Barmouth, the **Conway** at Conway, and the **Clwyd** near Rhyl are shorter Welsh streams which drain the Principality outside the basins of the Severn and Dee.

The Dee.—A number of mountain streams drain into beautiful Bala Lake in Merionethshire. The river which leaves the lake is the Dee. It flows north-eastward to Corwen, where it turns due east through the picturesque pass of Llangollen, with the Berwyn Hills on the right and the Llantysilio and Eglwyseg Hills on the left. The Dee now passes

[1] Compare the Thames Gap through the Chalk, p. 85.

into the Midland Plain, and receives the **Ceiriog**, which rises in Cader Berwyn. Its course is now from south to north on the whole, and it is hereabouts one of the most winding

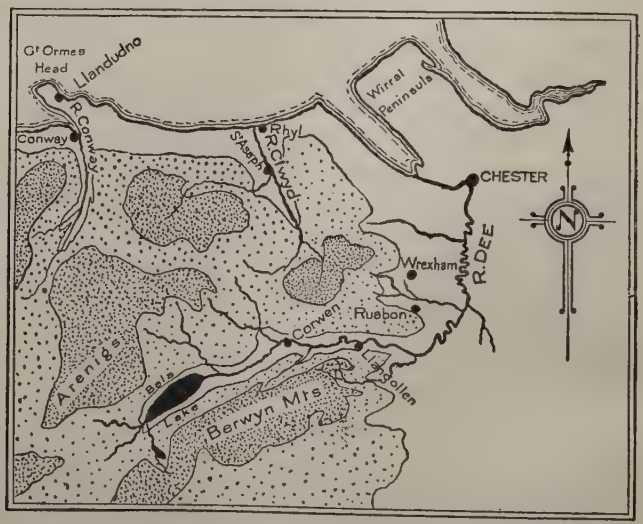


FIG. 31.—THE DEE AND OTHER RIVERS OF NORTH WALES.
Land over 600 feet is lightly stippled; over 1200 feet closely stippled.

rivers in the British Isles. At Chester it turns north-westward, passing through a straight channel, which is obviously artificially banked, before opening out into its great sandy estuary.

THE RIVERS OF IRELAND

Northern Rivers.—The **Bann** rises in the Mourne Mountains, and flows northward to Lough Neagh, into which another river, the **Blackwater,** flows from the high peaty moors to the south-west. **Lough Neagh** is the largest lake in the British Isles. It is supposed to be due to a lava-sheet of the Tertiary volcanic era which flowed across the valley of the Bann; and this damming up is thought by some to have been accom-

panied by a depression of the region now occupied by the lake during the earth-movements which accompanied the volcanic outbursts of that time. From the lake the river Bann flows almost due north over a somewhat monotonous plain until at Coleraine it forms a small estuary. The **Foyle** rises in the same peat-covered moors as the Blackwater mentioned above;

FIG. 32.—PHYSICAL FEATURES OF THE NORTH OF IRELAND.
Land over 600 feet is stippled.

it flows northward into the Caledonian land of North-West Ireland. Then it runs north-eastward in keeping with the main structure-lines of that old Caledonian land (compare the Ness, Findhorn, Spey, and Deveron). In the upper part of its course Strabane and Lifford are passed, and later Londonderry, below which the river soon begins to widen out into the great sandy estuary called Lough Foyle. At the northern end of the lough there are many evidences of comparatively recent movements of the crust, and also of gain of land by river deposits. The beautiful Vale of Limavady

here lies between the Sperrin Mountains and the western edges of the Antrim plateau.

Western Rivers.—It has already been pointed out that a belt of old rocks carries the structure of the Southern Uplands of Scotland through the Mourne Mountains and Newry. These rocks extend south-westward into the low peaty uplands of Monaghan and Cavan. From the slopes of these moorlands a number of streams collect to form the **Erne,** which flows to the north-west over the northern part of the Carboniferous Limestone plain. About one-third of the course is through two lakes, called Upper Erne and Lower Erne. Limestone is soluble in water containing carbon-dioxide in solution; when this water also contains weak organic acids derived from the peat of the moors, the solvent power is increased. Hence, many of the peaty rivers of Central Ireland have formed **solution-lakes,** which are primarily due to the solvent power of the soft water, and also to some extent to the damming up of the water by glacial clays. These shallow, irregular " solution-lakes " are a common feature in the peaty plain of Central Ireland. Those of the Erne may serve as a type; they are irregular in outline, variable in depth, but shallow generally, studded with islands of limestone which are etched in the way common to this rock in all rainy regions. Between the lakes the Erne runs through ordinary limestone country, with falls, rapids, and gorges of the usual type, and here stands Enniskillen. After leaving the lower lake the Erne passes Ballyshannon, and then enters wide Donegal Bay, where, at Bundoran, are fine cliffs of Carboniferous Limestone.

Where the limestone region of the Central Plain abuts against the Connaught fragment of Caledonia in the west, are solution-lakes similar to those of the Erne. Lough Conn is drained northward to Killala Bay by the river Moy; Loughs Mask and Corrib, with some smaller ones, are drained to Galway Bay by the rivers Robe and Black,

which enter the bay in company with the river Clare from farther inland.

FIG. 33.—THE SHANNON.

The low hills are shown diagrammatically; the figures opposite the Solution Lakes are heights above sea-level. (See also fig. 34.)

The Shannon.—This is usually said to be the longest river in the British Isles. It starts in the low hills south of the Lough Erne, and flows in a sluggish course through the western part of the Central Plain. (See fig. 33.) It continually expands into lakes—solution-lakes like those already mentioned—the

chief of these being Loughs Allen, Ree, and Derg. It receives tributaries on both banks which bring to it the peaty water so characteristic of Irish rivers ; the chief of these are the **Suck** on the right, the **Inny** and the **Brosna** on the left. After this sluggish, lake-expanded course, it encounters an obstruction in the older rocks which form the Slieve Bernargh on the right bank and the Silvermine Mountains on the left. Here it forms

FIG. 34.—PHYSICAL FEATURES OF THE SOUTH OF IRELAND.
Land over 600 feet is shown by stippling.

a series of rapids and a beautiful gorge as it passes through the "Gap of Killaloe." Beyond this it passes Limerick, with the Golden Vale on the left, and a little later opens out into a wide estuary, the inner part of which seems to be a solution-lake with a wide, tidal opening, and the outer part a ria similar to those of the south-west.

Southern Rivers.—In the south of Ireland there is a most interesting series of rivers which in the upper parts of their courses flow along downfolds of the strata and then turn off at right angles and cut transversely across the upfolds, to open into the Atlantic by wide openings like the sounds of South-

Western England. The following rivers belong to this series:—the **Bandon** with Kinsale at its mouth, the **Lee** with Cork and Queenstown, the **Blackwater** with Youghal, and the **Suir** with Waterford. The last-named of these is joined by the combined

FIG. 35.—RIVERS OF SOUTH-EASTERN IRELAND.
Land over 600 feet is lightly stippled; over 1200 feet closely stippled.

waters of the **Nore** and **Barrow** which have flowed from the middle of Ireland—the Nore from the Slieve Bloom uplands, the Barrow from the peaty moors in the neighbourhood of the well-known Bog of Allen. (See fig. 34.)

Eastern Rivers.—The **Slaney** and the **Liffey** both rise in the granite mountains of the Wicklows; the former runs westward and then southward to Wexford Haven, cutting across the granite and other rocks of Leinster in a course somewhat

analogous to parts of the upper Severn and upper Dee. The **Liffey** flows westward and then northward, and finally curves round to the eastward to enter Dublin Bay. In the upper part of this river there is some very beautiful scenery.

The **Boyne** is a sluggish river rising in the bog-covered uplands of Westmeath. It receives one of the numerous Blackwaters of Ireland, and the combined waters flow in a winding course past Drogheda to the Irish Sea. (See fig. 35.)

The only other Irish river that need be mentioned is the **Lagan,** which begins in the Mourne Mountains, and flows first northward and then north-eastward in a course similar to that of the Eden, or the Nith, or the Clwyd—that is, over a plain of New Red Sandstone. It passes Lisburn, which in situation is somewhat like Appleby, Dumfries, and St Asaph on their respective rivers. At Belfast the Lagan opens out into the spacious and important Belfast Lough.

THE BRITISH LAKES

Many lakes have been mentioned in connection with the rivers which drain them. The British lakes, as a whole, may now be treated very briefly.

Rock Basins.—Many lakes are true rock-basins worn out of solid rocks, probably by glaciers of the ice-age. These are exceedingly numerous in the Outer Hebrides, where the ground is literally strewn with them. The rock-surfaces of those islands are very much ice-worn everywhere. There are many also in the Inner Hebrides and the Western Highlands. Loch Coruisk in the Isle of Skye is a well-known example.

Glen Lakes.—These are long, narrow, and usually deep. They have frequently at the lower end a glacial moraine which acts as a dam. Glacial erosion has almost certainly gouged out some of the deep basins, but the very great depth of a few remains an unsolved problem. **Loch Morar** in the west of Inverness-shire is 1080 feet deep, far deeper than any part

of the sea on the continental shelf. A glance at the map shows that many of these lakes lie in troughs along the usual direction-lines of the Highlands—that is, in a N.E. to S.W. direction. Lochs Lochy, Oich, and Ness in the Great Glen, and Lochs Shiel, Ericht, Awe, and the northern part of Loch Tay, are examples. Many others lie with their long direction very nearly east and west; of these may be quoted Lochs Morar, Arkaig, Rannoch, and Earn. Others have their long direction N.W. to S.E., examples being Lochs Shin and Maree.

It is probable that the longer lakes of the English Lake District should be classed with these glen lakes, as many of them have glacial moraine barriers at their lower ends. The radial arrangement of these lakes is remarkable. (See fig. 12.) **Windermere** is the largest in area; **Derwentwater** is often claimed to be the most beautiful, its scattered wooded islands and the surrounding crags and mountain peaks making a most striking combination; **Wastwater** is the deepest, and has a gloomy grandeur all its own. **Thirlmere** is used by the City of Manchester for water supply; the dam at the end has been raised, and the lake thus enlarged. **Crummock** is similarly used by Workington. Some of the **Welsh lakes** are very similar, but smaller; Llyn Padarn, L. Peris, L. Ogwen are examples. **The Lakes of Killarney** in the mountains of Kerry are similar in many respects to those of the Lake District and the Welsh lakes.

Corrie Lakes.—In many parts of the British Highlands there occur roughly semicircular openings into the mountain masses which have steep, occasionally almost vertical, walls. These are called **Cwms** in Wales, **Corries** in Scotland. On the outer side of the opening there often occurs an irregular moraine, behind which is a lake basin. These corrie lakes occur frequently in the Highlands of Scotland, in the Cairngorm granite mountains, for example; also in the corries of Lochnagar and Goat Fell. Red Tarn lies in a corrie of Helvellyn; and

Llyn Dulyn, Glaslyn, and Marchlyn Mawr are corrie or cwm lakes in Snowdonia.

Lowland Glacial Lakes.—Scattered over many parts of the Lowlands of Scotland, the North of England, and Ireland are deposits of glacial boulder-clay. In irregular hollows among this clay are sheets of water. **Loch Leven,** in Fifeshire, is the best known of these in the Scottish Lowlands. The southern end of **Loch Lomond** is probably such a Lowland lake. This, the largest lake of Scotland, is obviously a compound lake: the northern part is a glen lake; the southern half is more like Loch Leven. It will be remembered that the great Highland boundary-fault crosses this lake, and thus one-half is in the Highlands and the other half in the Lowlands. Many Lowland lakes have been silted up or filled by the peaty accumulation of ages. Others have been artificially drained. The numerous *meres* of Ellesmere, in the north-western corner of the Midland Plain of England, are probably sheets of water in hollows of the clays left by the glaciers from the north and the Welsh hills.

Cheshire Meres.—The meres of Cheshire have originated in quite a different way. Under the surface deposits and the sandstones of the New Red Sandstone series of the district are beds of rock salt. The solution of this salt has caused the surface to sink in many places, and the depressions thus formed make the meres scattered over southern Cheshire.

The solution-lakes of Ireland and the Broads of Norfolk have been mentioned in connection with the rivers and coastal deposits of their respective regions.

CHANGES IN RIVERS AND LAKES

In Chapter IV. it was related how the British coasts have changed considerably within historic times, and it was hinted that in prehistoric times the changes were even greater. The changes known in history are relatively small compared

with the changes in the more remote past, because the historic period is relatively very brief.

It is the same with rivers and lakes. In the case of the latter it is evident to the most cursory observer that most lakes must be comparatively short-lived. Every flood brings down its load of debris, which is deposited at or near the place where the river enters the lake. Alluvial meadows and marshy land at the upper end of almost every British lake show that this has been going on in the past. Where rivers enter lakes from the side, the deposits may in course of time bisect the lakes. There are many obvious examples in the British Isles. Let an observer take his stand on High Stile or Red Pike and look down on **Buttermere** and **Crummock Water,** and he can have no doubt whatever that the flat land separating the two lakes is the work of Sail Beck, which he sees descending from the hills on the opposite side of the lake-valley, and of the smaller streams which rush down the hill-sides immediately in front of him.

Another excellent example is that of **Derwentwater** and **Bassenthwaite Lake,** which have been separated by the deposition of the alluvial flats of Portinscale. The river Greta from the east and Newlands Beck from the south-west have been carrying down their loads of debris for long ages ; and, of course, this deposition is continuing.

The same process is going on in the other mountainous regions, and the lakes of the Highlands and of North Wales, for example, are being filled by debris slowly, but surely. It is to be expected, therefore, that old lake-basins now quite filled with alluvial deposits will be found here and there, and these are actually common enough. It is also the case with many lowland lakes, many of which have ceased to be lakes within historic times, artificial drainage having helped in the process.

Rivers undergo changes too. It is common knowledge that they change their courses ; in the case of many of them, their windings have changed very considerably within historic

times. Old river-channels can be seen in hundreds of cases; and many really important changes can be proved by reference to historical records. Again, the changes in historic times are comparatively small compared with those which have taken

FIG. 36.—THE EAST YORKSHIRE DERWENT AND ITS PROBABLE CHANGES OF DIRECTION.
Dotted lines show the old courses to the sea.

place in the greater period of the prehistoric past. Three examples of these greater changes may be quoted in illustration of this part of the subject.

The Yorkshire Derwent.—This river rises in the Jurassic moorlands of north-east Yorkshire, not far south-west of Robin Hood's Bay. It flows south and then bends slightly to the south-east, as though making for an outlet to the sea at

Scalby, north of Scarborough. This would seem to be its natural outlet, and the valley there seems too wide for the very small stream which now occupies it. Instead of following this obvious direction the Derwent goes off to the south, and cuts its way through the fine gorge of Forge Valley. From there it drains the Vale of Pickering westwards, and afterwards cuts a second gorge through the Jurassic rocks at Castle Howard. The natural drainage of the upper Derwent above Forge Valley would seem to be to Scalby ; that of the Vale of Pickering would seem to be towards the low ground at Filey. Why is the drainage westward, and why has it been reversed ? It is almost certain that the old exits to the east were blocked by the North Sea ice in the Glacial Period, or by the deposits of boulder-clay and other drift left by that ice. The consequence of this would be the diversion of the drainage in another direction ; that is, the drainage was forced to the west, and the Derwent discharged itself into the Ouse instead of into the North Sea directly. (See fig. 36.)

The Hodder.—Another similar example of river diversion, or capture by another stream, is pretty clearly seen at the south-western end of the **Bowland Fells.** The Hodder comes from the moors, north and east of Slaidburn, flows to the south-west, and aims straight at an old gap between the hills, towards Preston. On reaching the neighbourhood of Chipping, however, it turns sharply to the south-east, and cuts a way through to the Ribble at Mitton, near Whalley. The obvious course would seem to be through the wide valley between Longridge Fell on the south and Parlick Pike on the north ; but the south-western end of this outlet was blocked by boulder-clay and other drift brought by the north-western glaciers. The wide valley referred to is now drained by the little river Loud in the opposite direction. (See fig. 37.)

The Trent.—From Burton to Newark the Trent seems to be aiming at the Lincoln Gap through the Jurassic escarpment. At Newark, however, it goes off to the north, but a trail of

pebbles brought by the old Trent from Cannock Chase shows the former course through that gap. It is said that in times of exceptional floods some of the water of the Trent still finds

FIG. 37.—THE PROBABLE CHANGE OF DIRECTION OF THE RIVER HODDER DURING THE ICE AGE.

its way to Lincoln. The explanation of this change is that a tributary of the Humber has cut back and offered to the old Trent a lower and easier course, so that the river has forsaken its old path, and the gap through the Lincoln cliff is now used only by the smaller Witham.

CHAPTER VIII

THE COASTS AND ISLANDS OF BRITAIN

THE British coast is as varied as the country's inland surface; this varied coast must now claim our attention. In that part of **Lincolnshire** called Holland there is a **flat coast** without anything in the nature of a cliff for miles. The boundary between land and sea is indefinite, and spring tides and gales carry the sea inland far beyond the limits of ordinary tides. Man wages a continual war with the sea, and quite recently he has " dyked in " large areas which will be drained in the usual way and added to the fertile agricultural land of that region. Compare this coast with the high **rocky cliffs** of the wild north-west of **Sutherland**—the cliffs of metamorphic rocks at **Cape Wrath** which rise in grand, irregular buttresses and reveal deep, gloomy caverns, or the hard, rocky cliffs a few miles to the east, which rise to 600 feet. The contrast between the coast of the Lincolnshire Holland and that of the north-west of Scotland is as great as can possibly be imagined. Again, compare the Lancashire coast from Fleetwood to Liverpool with the coast on the other side of England from Bridlington to Redcar. On the coast of the western county there are stretches of deltaic sand at Southport and Lytham, sand-dunes at Formby and South Shore, wasting cliffs of boulder-clay at Blackpool and Cleveleys. On the opposite eastern coast there are fine cliffs of chalk at Flamborough, Bempton, and Speeton; a succession of cliff-capes and bays in Jurassic sandstones and limestones from Filey

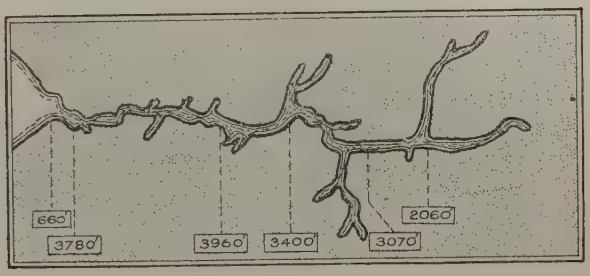
Brigg to Robin Hood's Bay; cliffs in Jurassic shales at Whitby, Staithes, and at Boulby, where they rise sheer to nearly 700 feet.

A third contrast in types may be seen in the rapidly disappearing, low cliffs of **Holderness** and north-eastern **Norfolk** on the one hand, and the hard, resistant granite cliffs of **Land's End** on the other. The former are disappearing at an alarming rate; the hard cliffs of granite in Cornwall must be wasting away, but the rate is so slow compared with man's lifetime that little change is recorded. One group of partly detached masses of these granite cliffs, weathered along the vertical and horizontal joints, is called "**The Armed Knights,**" as though they stood out from the land to defend it from the ceaseless attacks of the wild Atlantic waves. It is clear from these examples that the character of the coast depends very closely on the nature of the rocks; hard, resistant rocks usually form rugged and wild coasts, while soft sands and clays are rapidly planed down to level, monotonous coasts.

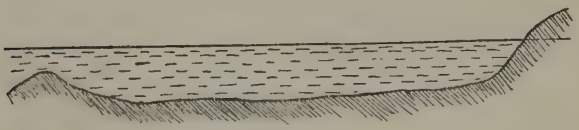
The wonderful variety of rocks, the infinitely varied action of the agents of erosion, the local uplift and depression of coastal regions in movements of the earth's crust, the long geological periods during which these factors have been interacting—all these account for the varied results which are at once an example of the difficulty and an illustration of the charm of all such natural-history studies.

Coastal Openings.—The British Isles are penetrated by many bays and gulfs; the merest glance at a map shows that. These openings are interesting and important; important because of their value as means of access into Britain, interesting because of their connection with the past physical history of the country. The western coasts are obviously much more indented than the eastern coasts; that is, the side facing the ocean is more cut up than the side facing the continent. The tempting conclusion that the Atlantic waves have produced the western coastal openings is only partly true, and

the help of other agents of erosion—rain, rivers, and glaciers—together with faulting and depression of the earth's crust, must be called in to explain the irregular character of the western coasts.



The Sogne Fiord, Norway.
Depths are given in feet.



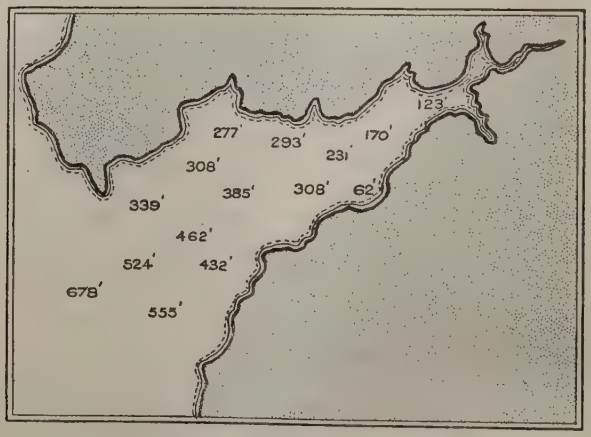
Longitudinal Section of a Fiord.

Transverse Section of a Fiord.

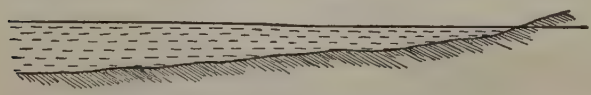
FIG. 38.—MAP AND SECTIONS OF A TYPICAL FIORD.

The coastal openings are varied in character. Some of them are not easily classified, partly because they are not fully understood, but there are many which clearly belong to well-known types of coastal openings. The **fiords** of the north and west of Scotland and of the Donegal region in Ireland have true fiord characters—that is, they are long, narrow, and deep, and maintain a fairly constant width and depth throughout a great part of their length. They are like the typical fiords of

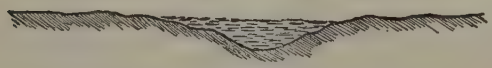
Scandinavia. Their origin has been the cause of much discussion, and certainly the last word has not been written, but it may be said without any question that they are old river



The Ria de Muros, Northern Spain.
(Richtofen first described Rias from that region.) Depths are given in feet.



Longitudinal Section of a Ria.



Transverse Section of a Ria.

FIG. 39.—MAP AND SECTIONS OF A TYPICAL RIA.

glens, which have been depressed below sea-level. The higher parts of the neighbouring hills generally show the sharp crag and pinnacle; the lower parts, nearer the water's edge, have smooth, rounded outlines. Glaciers have smoothed away the sharp crags of these lower regions; the upper parts still

project into the atmosphere as evidences of the ordinary weathering action of frost and rain.[1]

The **ria** is also well represented in the British Isles. This is a gulf which narrows rapidly towards the head, and

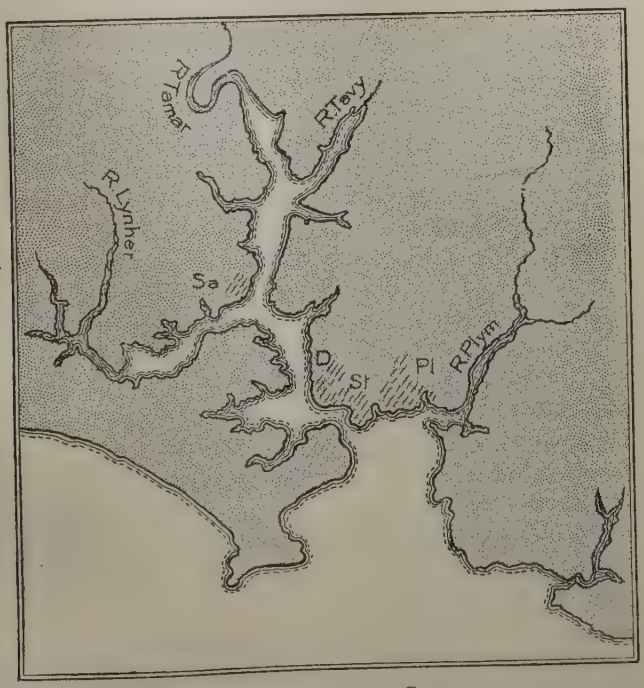


FIG. 40.—PLYMOUTH SOUND.

The most important of the compound, ria-like branching openings of the south-west of the British Isles.

Pl., Plymouth; St., Stonehouse; D., Devonport; Sa., Saltash.

becomes shallower at the same time. It is thus sharply distinguished from the fiord. There is a fine series of British rias, as already mentioned, in the south-western corner of

[1] See *The Groundwork of Modern Geography*, G. Bell & Sons, Ltd.

Ireland, from Long Island Bay northwards to and including the mouth of the Shannon.

In the Armorican regions of south-western Britain there are examples of another type of considerable interest and maritime importance. This is the **compound ria** or **sound,** of which Plymouth Sound and Falmouth Harbour are notable illustrations. The former, more especially, consists of a fine series of ria-like arms, and its usefulness to mercantile shipping and to the British Navy can scarcely be overestimated. Probably Milford Haven, Wexford Harbour, Waterford Harbour, and others along the south coast of Ireland, should be placed in the same class.

Other openings with some, at least, of the characteristics of rias are the **Firths** of Forth and Tay. These are wide, drowned valleys which on the whole become shallower as they become narrower. Though they are called firths, they are not fiords in any sense, being quite different in character.

The **Firth of Clyde** is obviously a complex set of openings of various types. The Gareloch, Lochs Fyne, Long, Goil, and Striven, and the Kyles of Bute are fiords ; the mouth of the Clyde in the restricted sense from below Glasgow to Greenock and Craigendoran is ria-like ; the southern part of the greater gulf is probably a sunken block similar to the Minch—that is, a **rift-trough.**

Many of the fiords, rias, sounds, and other openings are of exceedingly great value to a maritime people ; but some coastal openings are so silted up as to be of comparatively little use for shipping. Among these are the Solway " Firth," the inner part of Morecambe Bay, and the Wash. Only small craft can use these openings.

Islands and Island Groups.—The island groups of Britain are numerous, varied in character, and important. The **Orkneys,** immediately to the north of Scotland, are outliers of the Old Red Sandstone plain of Caithness and the Moray Firth. The grand coastal stacks of Thurso, Duncansby Head,

and Dunnet Head on the mainland are matched by the well-known Old Man of Hoy in the Orkneys. The bedding planes

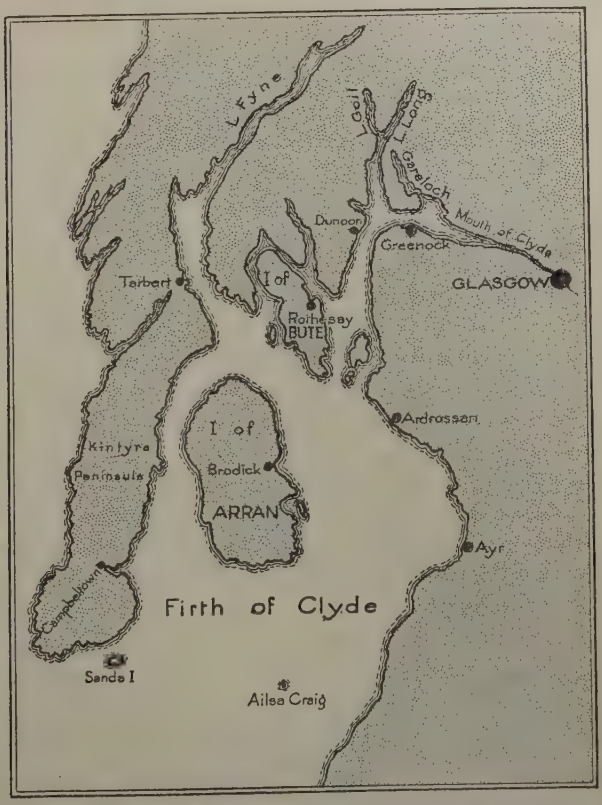


FIG. 41.—THE FIRTH OF CLYDE AND ITS BRANCHES.

The northern and north-western branches are fiords; the mouth of the River Clyde is ria-like in structure; the wide entry is probably a sunken rift-trough like the Minch.

and master-joints of these flaggy sandstones lend themselves to the cutting of the immense stacks and chasms which are characteristic of the coasts of Caithness and the Orkneys. Tidal currents race between the various islands, and especially

through **Pentland Firth,** at double the speed reached elsewhere on the British coasts. The men of the mainland coast-towns and of the Orkneys are in consequence expert sailors and fishermen ; they are trained in a hard school.

The more distant **Shetlands** are a true part of old Caledonia, the worn-down and fractured remains of the ancient Alpine mountains of which Donegal, the Scottish Highlands, most of Scandinavia, and Finland are the larger fragments. The rocks are of the same type and of the same age. Small patches of the Old Red Sandstone in the south are remainders of the Caithness-Orkneys plateau which once extended farther to the north. The Shetlands have the scenery of the Highlands on the subdued scale, with coastal features like those of the west of Scotland and the north-west of Ireland. There are wide stretches of peat on the worn-down mountains, and in this respect, too, the Shetlands are like the Highlands of the mainland.

Two great groups of islands lie to the west of the Scottish Highlands — the **Inner Hebrides** and the **Outer Hebrides.** Separating them is a drowned rift-valley, the **Minch,** probably similar in origin to that of the Central Lowlands of Scotland. The Inner Hebrides show two distinct types of structure and scenery. The islands lying immediately to the west of the Argyllshire mainland, including Islay, Jura, Colonsay, Scarba, and Luing, are obviously outliers from the Highlands, and are not only parallel to the **Kintyre peninsula,** but are like it in general build. It would require only a slight depression of this region to convert the long peninsula into another series of islands, the sea coming through at Ardrishaig and Tarbert, and forming straits similar to the Sound of Islay. Gigha Island is a detached bit of the Knapdale massif, due to such a regional depression. Iona, Tiree, and Coll, lying beyond Mull, are also similar in character.

There is a second group which is quite different in origin and in scenery, namely, Mull, Muck, Eigg, Rum, Canna, and

Skye. These are built, for the most part, of Tertiary igneous rocks, which give rise to a different kind of scenery. The rugged Cuillin Hills of Skye, the terraced flat-topped hills of

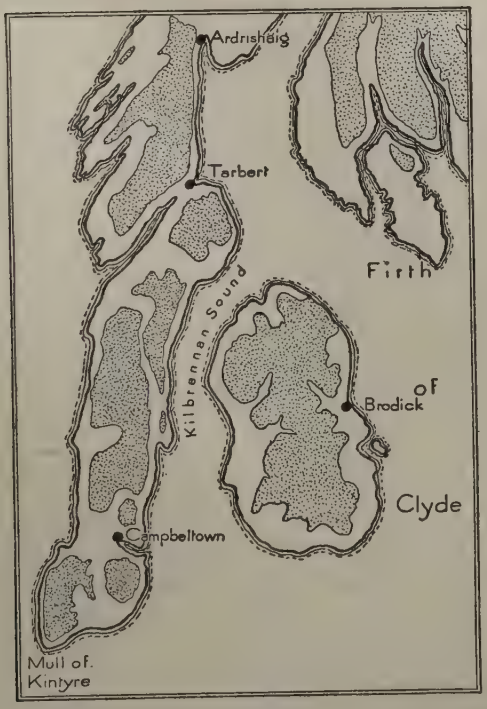


FIG. 42.—KINTYRE PENINSULA AND THE ISLE OF ARRAN.

(See also fig. 41.) Land over 600 feet is stippled.

basalt in Mull, the basaltic pillars of Fingal's Cave (in Staffa), the turreted pitchstone of the Scuir of Eigg are characteristic phases of scenery different from the general type of the Western Highlands of Scotland. The narrow Sound of Mull, the Sound of Sleat, and Raasey Sound are comparatively slight geological "accidents."

The **Outer Hebrides** are Caledonian in structure and in scenery. From the Butt of Lewis in the north to Barra Head in the south, through nearly two degrees of latitude, the islands show great similarity to western Sutherland. A part of the old Caledonian Mountains, perhaps the dissected edge of an old plateau, has been worn for long ages by the fierce rains and the breakers of the Atlantic. The whole is often referred to quite appropriately as Long Island, and separate parts are known as Lewis-Harris, North Uist, Benbecula, South Uist, and Barra. The Sound of Harris and the Sound of Barra are names which need no explanation. Ben Clisham, in the Forest of Harris, rises to 2600 feet ; Ben Mhor in Lewis, Ben More and Hekla in South Uist are other conspicuous mountain masses. These Outer Hebrides are remarkable for the number of lakes and marshes, in this respect being much like Finland—the worn-down *eastern* edge of the ancient Caledonian system.

The islands inside the Kintyre peninsula are Inchmarnock, Bute, the Cumbraes, and Arran. The Highland boundary-fault cuts across this group ; and the southern end of Bute, the whole of the Cumbraes, and the southern end of Arran belong to the Midland Valley of Scotland. Northern Bute and Inchmarnock are bits of the true Highlands. The northern part of Arran is the same, and a granite mass rises in Goat Fell to 2800 feet. The scenery of Goat Fell is famed for its wild beauty, and shows the same crags and corries as the Cairngorm group.

Ailsa Craig stands, sentinel-like, towards the North Channel. It consists of a peculiar rock, allied to granite, which contains a beautiful blue mineral, riebeckite. Ailsa Craig may be compared with the famous Bass Rock and the Isle of May at the entry of the Firth of Forth—igneous remnants of a different composition.

Ireland, like Great Britain, has no considerable islands on its eastern coast. On the north coast is **Rathlin Island,** an

outlier of the igneous rocks which occupy the Antrim plateau. Chalk is seen in the cliffs, underlying the dark lava-flows of Tertiary age, just as on the opposite mainland. Farther to the west, off Donegal, are islands similar in character to the Islay-Jura group off the neighbouring coast of Scotland. **Tory Island** consists of schists, while **Aran Island** is a mass of granite. **Achil Island** is separated from the Mayo mainland by a very narrow strait across which an iron bridge has been erected. The island and the adjoining mainland consist of rocks akin in age and character to the rocks of Donegal and the Scottish Highlands. **Clare Island** and **Inishshark** are the most southerly relics of the ancient Caledonia which, no doubt, once extended much farther to the west.

In Galway Bay the Carboniferous Limestone of the Central Plain reaches the coast, and the **Aran Islands** are residual masses showing a former extension of this formation to the west. With the Shannon estuary commences the series of peninsulas and rias already referred to. At the end of four of these peninsulas of the Old Red Sandstone there are island masses separated from the mainland by narrow straits. These are **Great Blasket, Valencia, Dursey,** and **Cape Clear Islands,** all with their axes running slightly to the south-west in keeping with the trend of the folds in that part of Ireland. Valencia is interesting as being the starting-point of Atlantic cables.

Returning to Great Britain, the Welsh islands may now be described. **Anglesey** is a worn-down summary of North and Central Wales. It is separated from the mainland by the narrow Menai Strait cut out of a downfold in Carboniferous Limestone and Coal Measures. This strait is so narrow that it is crossed by two famous bridges—the Tubular Bridge of the London, Midland, and Scottish Railway and the Menai Suspension Bridge for foot-passengers and ordinary vehicular traffic. In the axis of another downfold seven or eight miles to the north-west and parallel to the strait, the sea could very readily make a second channel and thus divide the island into

two parts. It would require only a slight depression of the land to bring this about.

The contorted rocks of Holyhead and western Anglesey are reproduced in the south-west of the **Lleyn Peninsula** and in **Bardsey Island**; the granite reminds one of the Nevin granite in Carnarvonshire; and the Carboniferous limestone of the north is obviously the counterpart of the Great Orme peninsula.

FIG. 43.—THE ISLE OF ANGLESEY.
MM.=Malldraeth Marsh and Sands.

Puffin Island, standing north of Anglesey and looking towards the Great Orme, is a relic of the once continuous limestone. The whole of **Anglesey** is worn down to a comparatively low level. This moderate elevation, a mingling of glacial drift, and the warm winter climate cause Anglesey to be fairly fertile and make it one of the best cattle-rearing areas in the British Isles.

Leaving Anglesey and glancing at the islands at the western end of South Wales, **Ramsay Island** has rocks like those of the St David's peninsula, and **Skomer Island** is an outlier from the igneous rocks of the Milford peninsula. In the same way

Worm's Head Island is a detached relic of the former extension of the Carboniferous Limestone of the Gower peninsula.

Lundy Island and the **Scilly Isles** are granite fragments, relics of a former Armorican land. They are similar to the granite masses which form the moorlands of South Devon and Cornwall. The **Channel Islands** are related to the Cotentin peninsula of France in the same way. These islands, like the Scilly Isles, are favoured with very mild winters, and are noted for early vegetables, flowers, and fruit.

The **Isle of Wight** is separated from the corresponding parts of Southern England by the Solent and Spithead. The northern part of the island belongs to the Hampshire Basin ; the southern half consists of an upfold of the Chalk and other rocks of the Cretaceous system. The Culver Cliffs in the east and the Needles in the west are typical cliffs and fragments of Chalk. The cliff scenery of the island is famous—Sandown, Shanklin, and Ventnor being especially well known. Spithead and the Solent Channels lie in a trough where the Tertiary rocks overlie the Chalk.

The **Isle of Man** summarises features from the four surrounding countries. The southern three-fourths is mountainous, and has, in a subdued way, many of the characteristics of the neighbouring mountain regions. From Ramsey westward by the mouth of Sulby Glen runs the boundary " wall " of ancient rocks ; these rocks occupy almost all the island from that line to the Calf of Man at the south-western end. These old slaty rocks are similar in character to the Skiddaw Slates of the northern part of the English Lake District, and the scenery reminds one of Skiddaw and Saddleback. Granite masses at Dhoon and Foxdale add to the likeness to the mainland regions. The Lake District rim of Carboniferous Limestone is represented at Castletown, where beds rich in fossils occur which are like those of the north-west of England.

Snaefell, the highest point, rises to a little over 2000 feet,

and, as already pointed out, the mountains of the five similar regions can be seen from its summit on a clear day. The cliff scenery of the island is similar to that of the south-west of Scotland, and is frequently very fine. Maughold Head, near Ramsey, and historic Spanish Head, opposite the detached Calf of Man, are the finest of the rocky headlands.

From Ramsey and St Lazare northwards is a plain which terminates in the Point of Ayre. Marshy low-lying parts of it are known as the Curragh. The plain has a substratum of New Red Sandstone rocks like those of the west of Cumberland and the Vale of Eden. These rocks are buried under a thick coating of drift—sand, gravel, and glacial clay. The northern part of the island is thus quite different in character from the southern part, and may be compared with the New Red Sandstone extensions which penetrate the mountain regions of southern Scotland, Ireland, Wales, and England.

CHAPTER IX

THE COASTS AND ISLANDS OF BRITAIN (*continued*)

COASTAL OUTLOOK

THE eastern and southern coasts of Great Britain are **continental.** Not only do they face the continent, but they are similar in character to the coasts of the mainland opposite ; in fact, they are *of* the continent. The intervening narrow seas are either shallow trenches like the **Strait of Dover** and the **Channel,** or a plain very slightly depressed below sea-level, as in the case of the **North Sea.** To appreciate the coastal similarity more fully, it may be well to study it in some detail. Beginning in the south-west of England, Cornwall and Devon are like Brittany and the Cotentin ; they belong to the same ancient Armorican land which once extended far to the west. Dorset and Hampshire are similar in character to Normandy ; the south-eastern angle of England is like north-eastern France and western Belgium ; the Weald corresponds to the Boulonnais. The boats which cross from Newhaven leave the Chalk of the South Downs to enter a small estuary in similar Chalk rocks at Dieppe ; the greyish-white Chalk cliffs of Folkestone and Dover are the counterpart of Cape Gris Nez across the narrow strait. The breach of the sea from the funnel-shaped south-western corner of the North Sea to the wider and older Channel entry must have been made since the coming of man to Britain.

The Tertiary and Glacial lands of East Anglia are similar

to Flanders, and, in a way, the Thames corresponds to the Scheldt, the Vaal, and the Lek, and Harwich looks across to the similarly placed Hook of Holland on the other side of the shallow sea. The Holland of the Fen-lands is like the continental Holland ; and the disappearing coasts of north-east Norfolk and Holderness correspond to the Frisian Islands of the eastern Netherlands and north-western Germany, while the Lincolnshire coast is similar to the western coast of Jutland. The Chalk and Jurassic cliffs of Hunstanton and Yorkshire are represented across the North Sea by the Chalk cliffs of Denmark and the coast of Malmo in south Sweden.

Even the very old Caledonian lands of Britain have obviously been cut off by earth-movements and denudation from the Scandinavian lands of the same geological age, and the structure-lines in Britain correspond in direction to those of Scandinavia and Finland. In short, Britain is continental in origin, and its eastern and southern parts have been profoundly influenced both in prehistoric times by the former connection, and since the dawn of written history by this outlook across the narrow seas.

Until the end of the fifteenth century the British Isles were at the edge of the then known world : to the Briton of those days the "world" lay to the east and south-east ; the unknown lay to the west. With the discovery of America and the mastery of the ocean the **western coasts** of the British Isles assumed a new importance. They became **points of departure** to distant and productive lands, and great ports—Bristol, Liverpool, Glasgow—with an oceanic outlook, grew up to deal with the new traffic.

Coastal Changes.—The western coasts are wild, hard, and rugged ; the eastern and southern coasts of England, from the Tees to the mouth of the Exe, are made of the younger rocks and are rapidly being washed away. Within historic times the south-eastern coasts have been changed very considerably, and soft, low cliffs have gone. For example, many square miles

of land have disappeared from the **Holderness** coast in historic times ; and the same may be said of the north-eastern angle of Norfolk. The old port of **Ravenspur,** once a rival of Hull, disappeared long ago. The scour of the combined Atlantic

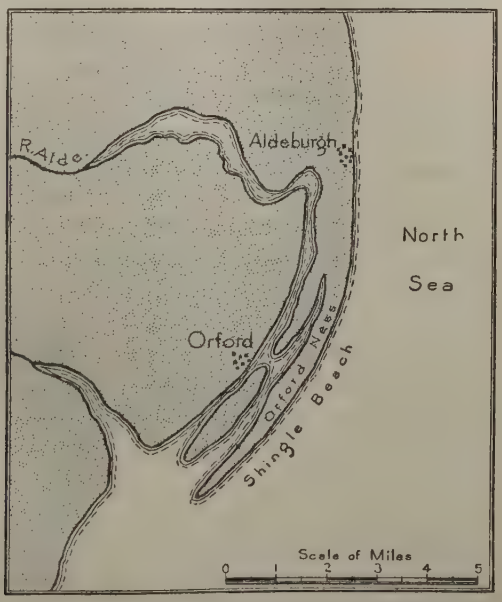


FIG. 44.—THE RIVER ALDE, IN SUFFOLK.

Showing its deflection by the tide-drifted material from the north. The Alde formerly entered the North Sea at Aldeburgh. A long shingle beach has been formed inside which the River Alde now flows roughly parallel to the North Sea coast.

and tidal drifts sets from north to south along the east coast, and the eroded material has been swept southward to be deposited at the Spurn, in the Wash, and on the eastern coast of Norfolk. The re-deposition of this coastal waste is very important ; many square miles of the newly formed land have been recovered round the Wash ; at **Aldeburgh** in Suffolk there have been large gains, accompanied by the accumulation

of lowland peat, since the Ordnance Survey map of 1838 was made. (See fig. 44.)

In **South Essex,** on the northern shores of the Thames estuary, new lands have been made from the coastal waste combined with the alluvium of the Thames ; in the **Romney Marshes,** on the southern side of the great estuary, many square miles have been recovered from the sea ; and farther south still, **Dungeness** is an ever-growing promontory of sand, which has already silted up the old estuary of the Rother.

There are some parts of the western coasts where similar changes may be recorded. The Lancashire coast may be quoted again. At Blackpool and Cleveleys the erosion of the cliffs of boulder clay has been so rapid that many acres of land have disappeared within the past forty or fifty years. At Southport, on the other hand, the drift of the Mersey material from the south combined with the alluvium of the Ribble has added vast stretches of new land to the foreshore. On the west coast of England the combined Atlantic and tidal drift sets from south to north as far as Morecambe.

The land thus reclaimed is not, as a rule, available for agriculture immediately ; usually some twenty years at least must elapse before it becomes good farming-land. In many places the new land has been planted with the maritime pine (*Pinus maritima*), and so has been made of immediate value. The grasses known as " rice-grass " will grow well, even when the newly-reclaimed land is occasionally submerged by spring tides, and by its decay from season to season it adds to the value of the new soil and hastens the process of complete reclamation. On the whole, it is probable that so far as Britain is concerned the loss by erosion during historic times has been quite compensated by land thus recovered from the shallow seas.

Sand Dunes.—These are common on many parts of the British coast, especially where it is low and flat. Beach sand is left exposed at each ebb-tide, and in fine weather the sand is

gradually dried while the tide is low, and is then blown landwards by the prevalent winds. Here it forms the shifting **dunes** so common on many parts of the western coasts where the commonest winds blow from the Atlantic ; and there are also fine stretches of them, perhaps not quite so extensive, on the east coast—the sand here having been blown landwards by the less frequent easterly winds.

Dunes are very common in parts of Cornwall and Devon ; among the more famous of these are the extensive sands near Perranporth, where at the village of **Perranzabuloe** [1] the church had been buried for centuries, but was uncovered by digging away the sand in the early part of the nineteenth century. At Kenfig on the east side of **Swansea Bay** a village has been overwhelmed by sand dunes within historic times. Sand dunes have buried roadways and hedgerows in Ayrshire within very recent times ; and a similar story may be told of stretches of farm land on the shores of the Moray Firth, in Aberdeenshire, and in Fifeshire, where fertile lands have been covered by the advancing sand. At least one famous seaside resort and fishing town seems to owe its site to sand dunes formed since Saxon times. Less than a thousand years ago there was a great estuary at the head of which stood **Norwich,** and on mediæval maps that city is always represented as situated on an arm of the sea. The drifted and blown sand on which **Yarmouth** stands became firm ground in the eleventh century. The whole entrance of the ancient estuary has thus been dammed up, and the dunes are still increasing in height and width. The famous **Broads** owe their origin to this wind-drift combined with sea-scoured material and river alluvium ; and much cultivated land has been recovered behind the line of dunes.

Whilst sand dunes thus overwhelm fertile land and sometimes cover up whole villages, they often exercise a protective function by acting as barriers against incursions of the sea. In the

[1] In sabulo = in the sand.

case of the Yarmouth dunes quoted above, the sea has been unable to make any inroad during the last half century at least. Dunes are not always " wandering " or drifting inland, for they may become more or less firm and fixed in position owing to the growth of the " Sand Marram " which is nearly always present. On many of the links of the British coasts this plant is present in great abundance, and the dunes are correspondingly firm and stable.

Coastal Elevation and Depression. — The above studies give some idea of losses and gains of the coasts due to erosion by frost, rain, and the sea, through deposition by rivers at their mouths, by the scour of the currents which sweep slowly round our islands, and by the action of winds. There are other losses and gains of coast-lands owing to local elevation and depression of the land. **Raised beaches** or marine terraces are seen on many parts of the Scottish coast, and less frequently on those of England and Wales and Ireland. Caves and sea-carved rocks are often seen far above the reach of the present waves. These indicate recent elevation of the land, and, of course, some changes in the form of the coast. Near Larne, in north-east Ireland, there is a raised beach in which chipped flints (the work of men) are found, and it is thought that the uplift there has occurred since man came to the British region.

On the other hand, so-called **submerged forests** and peat-beds are found on many of the English coasts ; examples are seen on the coasts of Cheshire and Lancashire, on the Bristol Channel coast, near the mouth of the Tees, and in different parts of Scotland and Ireland.

In many of these, roots of trees fixed in the soil on which they grew are seen below the present level of the sea ; and in other cases fragments of such forests are washed up at spring tides. These depressed land-surfaces indicate local subsidence, and obviously show that the coast where they occur must have been changed in form. In the neighbourhood of

Portrush, to the east of the headland, one may see a raised beach with old sea caves, while in a small bay to the west there are the remains of vegetation (a so-called " submerged forest ") which are only visible at low tides. The changes thus indicated are in addition to those of loss and gain by erosion and deposition.

Tides on the British Coasts.—Among the most important and interesting features connected with our coasts are the **tides**: important because of their influence on shipping, important also because of the way in which they carry from shallow beaches and tidal estuaries waste matter of all descriptions, and so make our seaside resorts and ports cleaner and healthier.

The attraction of the moon produces a great tidal wave in the ocean. In the open ocean this is seen simply as a rise and fall of the water to a height of not more than three or four feet. For a little over six hours the water gradually rises to a maximum; for about the same time it then gradually falls. This takes place twice in slightly over a day—about twenty-four hours fifty-four minutes. If there were no obstructions due to the continents this rise and fall would pass round the world as a great wave, so rapidly that at any given point each succeeding crest would pass at intervals of nearly twelve and a half hours. There is little or no translation of water in the open ocean; it is simply an up-and-down wave-motion which travels at the rate mentioned.

The oceanic tidal wave is obviously very much interfered with by the irregularly shaped continents, and it is only possible to make general statements about its course. When it reaches the neighbourhood of the British Isles, coming from the south-west, it is rapidly changed in character from an oceanic wave to one in a shallow sea. This change takes place as it reaches the continental shelf, and the changed character becomes more and more evident as it passes farther into the shallower seas. The amplitude of the wave—that is, its

vertical rise and fall—becomes very much greater than in the open ocean. When the tidal wave enters shallow bays and straits there will obviously be a good deal of friction against the bottom and the sides; this sets up a true current which frequently flows at the rate of four or five miles an hour. Through the **Pentland Firth**—the channel between the Orkneys and the Scottish mainland—the tidal current races along at the rate of ten or eleven miles an hour at the time of high tide. This is the most famous of British tidal currents; but there are others, such as the so-called "**whirlpool**" of Corrievreckan between the isles of Jura and Scarba.

When the oceanic tidal wave reaches the south-western part of the British continental shelf it divides into three branches. (See fig. 45.) One passes round the outside of the islands to north and round to east; a second goes through St George's Channel into the **Irish Sea**; and the third through the English Channel and the Strait of Dover to the **North Sea.** The latter wave reaches the mouth of the Thames about eight hours after it passes the Channel entry and about twelve hours after it leaves the nearest part of the deep ocean. The north-western branch travels round the North of Scotland and reaches the Moray Firth in about twelve hours and the converging mouth of the Thames in about twelve hours more. It is obvious that the crests of two tidal waves will reach the Thames estuary at the same time, the northern one being twelve hours older than that which has come through the Channel. The effects of these two tidal waves are added together, and the reinforced wave penetrates the estuary to a great distance. The consequent great rise of the tide in the Thames (18 feet) is of considerable advantage to the port of **London.**

A curious and interesting case of **divided tidal waves** is experienced at **Southampton.** The port stands on Southampton Water, and opposite the wide estuary mouth is the Isle of Wight. There are two entries—the Solent to the west and

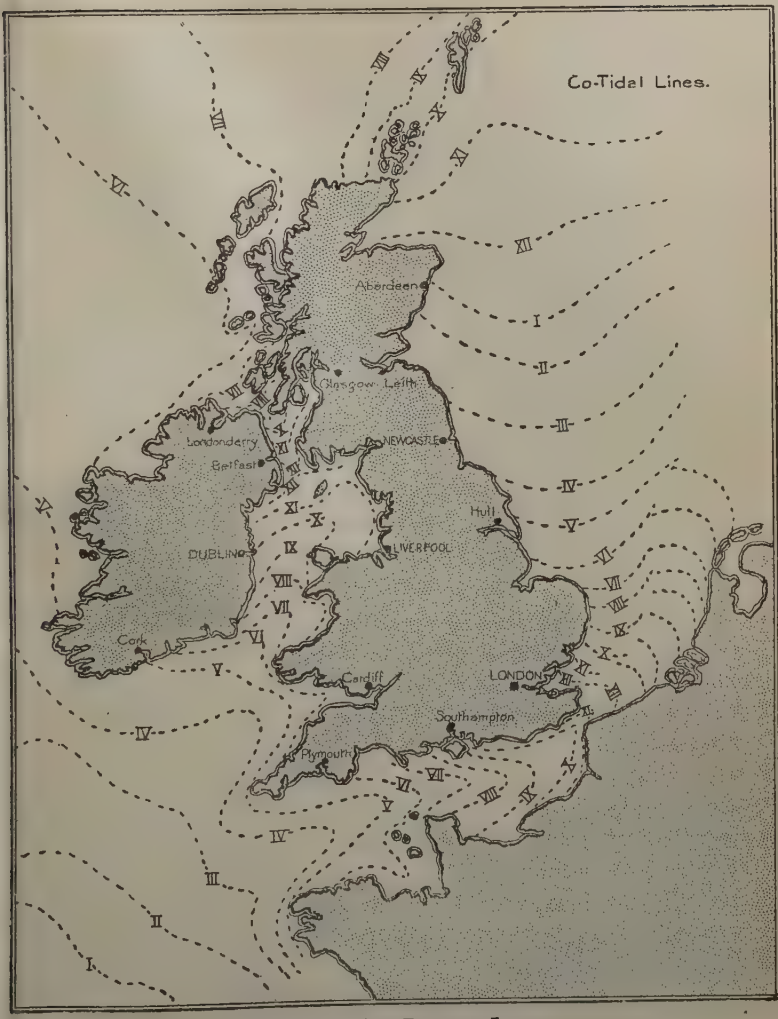


FIG. 45.—THE BRITISH ISLES.

Showing co-tidal lines and chief ports.

Spithead to the east. The Channel tidal wave divides at the obstacle of the Isle of Wight ; one branch enters the Solent, and the other pulsates round into Spithead by the eastern end of the island. The latter wave reaches Southampton Water two hours later than the Solent branch, and thus Southampton docks have the advantage of four tides a day. It is scarcely necessary to point out how important this is to the great port of Southampton.[1]

It is quite clear that with the rise of a tidal wave a large volume of water must be thrown on the shallow, shelving coast ; and with the fall of the tidal wave this will be withdrawn again. A converging river mouth will obviously tend to heap up the water of the advancing wave, and many estuaries show interesting results. Thus, in the narrowing and shallowing **Bristol Channel** and Severn mouth the tidal wave is concentrated on the narrowing front to such an extent that during spring tides there is a maximum rise of forty feet. The front of the tidal-wave current races up the Severn estuary like an advancing wall of water ; such a wave is called a *bore*. In the Trent a similar but smaller wave front is called the *eagre* by the boatmen. The upper end of Morecambe Bay, near Arnside and Silverdale, the converging Solway, and the Wash have tidal-wave currents which race over their shallow sand-banks and mud-flats with great rapidity.

A most important result of the tidal wave in our shallow seas is the way in which the docks of the ports are filled with water every twelve and a half hours, thus aiding our shipping. It also brings shipping much farther inland than would be possible in a tideless sea. The scouring effect of the inrushing and outgoing wave is also important, and helps to keep clear some of our estuaries. This is particularly the case with the great port of **Liverpool-Birkenhead.** The narrow bottle-neck entrance to the wide Runcorn basin is thus scoured continually, and deep water for the port is assured.

[1] Portsmouth has similar tides.

CHAPTER X

THE WEATHER AND CLIMATE OF BRITAIN

CLIMATE is average weather; the latter needs no definition. British weather is variable and uncertain; but when an average for a series of years is obtained it is found that general statements can be made which hold fairly well. For example, the month of November in any one year may be fairly fine and dry; but when the average rainfall of, say, twenty years is obtained, it is found that November is, on the whole, a rainy month. In this chapter we shall study the **average** winds, rainfall, and temperature of the British Isles, but before approaching these we must deal with the position of the British Isles.

Latitude.—Britain lies between 50° N. and 60° N., and the latitude of Newcastle, Carlisle, and Londonderry—55° N.—may be taken as the average. The altitude of the mid-day sun on Midsummer Day is only 58½°; it is 35° at the equinoxes, and only 11½° on Midwinter Day. From any point of the Equator the mid-day sun can never be at a lower altitude than 66½°. For reasons discussed in books on the principles of geography, sun force is only moderate in the British Isles; the region lies within the cool temperate zone.[1]

Continent and Ocean.—This is the second factor in the world relationships. Britain looks eastward towards the greatest plains in the world. From the eastern Pennine slopes there are **continental plains** through nearly half a hemisphere

[1] See *The Groundwork of Modern Geography*, G. Bell & Sons, Ltd.

of longitude, for the low Urals make but a slight break in the great Eurasian plains. These vast plains stretch across a great continent, and they are largely in the temperate zone ; they therefore show great extremes of climate. The winter cold is intense, and the pressure of the atmosphere is consequently high ; in summer the temperature is relatively high and the pressure is low. In European Russia the January temperature in the latitude of Newcastle is about 10° F. on the average ; in mid-Siberia in the same latitude the January temperature is about −10° F.[1] There is high pressure in winter and low pressure in summer over the middle of these great continental plains.

Britain not only faces these plains, but south-eastern England really forms the western fringe of them ; this is a factor of great importance in the climate of the British Isles. On the other side is the deep and wide ocean, quite close to the western edge of Ireland and Scotland, for the continental shelf is narrow beyond the Outer Hebrides and western Ireland. Thus the British Isles have an oceanic outlook on the west and a continental outlook on the east.

The great **Atlantic Ocean** influences the climate in two ways which are closely interwoven. A surface drift of warm water sets toward north-western Europe from the North Atlantic ; this drift is fed by the more definite current of the famous **Gulf Stream.** Some of the abundant heat of the tropics is thus " drifted " towards the British Isles. This Atlantic warm surface-drift in turn influences the winds, causes them to be warmer, and gives them a greater capacity for moisture. It is this abundant moisture, brought by the warm winds from the Atlantic, that carries so much winter warmth to Britain.

The Winds of Britain.—A table of winds, or a **" wind-rose,"** compiled from the records of any British climatic station, at once makes clear the fact that winds blow more

[1] The average January temperature of Britain is 40° F.

frequently from the west and south-west than from any other quarter. (See fig. 46.)

For an explanation of the westerly character of the winds we must look to the atmospheric conditions over the North Atlantic and over the great Eurasian continent. Over the Atlantic, in the neighbourhood of the Azores, there is an area of high pressure which varies somewhat during the year. In the neighbourhood of Iceland there is generally an area of low pressure. On the great continent there are strongly marked

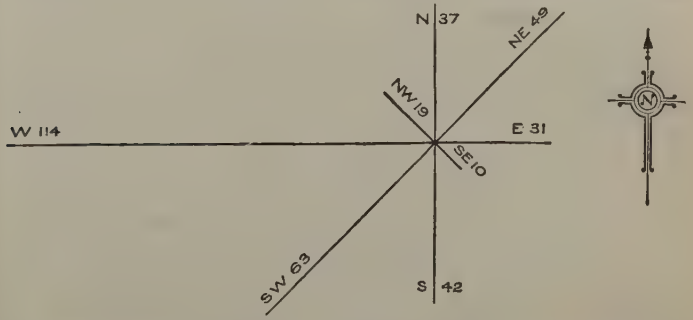


FIG. 46.—A WIND ROSE.

Showing the average direction of the prevailing winds at Stonyhurst College Observatory, for the years 1900–1920 inclusive. given in average days per year. The figures were kindly supplied by the Rev. A. L. Cortie, S.J., F.R.A.S. Director of the Observatory.

seasonal conditions—high pressure in winter and early spring, low pressure in summer and autumn. A diagram of the winter **pressure systems,** with the westerly and south-westerly winds which may be expected on the whole, is given in fig. 47.

When the Azores high-pressure area shifts northward in the summer, and the continental high-pressure has been replaced by the low-pressure of summer, there is a tendency for the prevalent winds to become more westerly and north-westerly. This change is very important. The south-westerlies of winter bring warmth, as already explained; the westerlies and north-westerlies of summer will obviously bring a cooling influence. This relatively small seasonal change clearly helps

to bring about that evenness of temperature which is one of the features of the British climate.

In late winter and early spring the continental high-pressure system frequently extends to Britain. The cold east winds so often experienced in the spring are due to this extension of the continental high-pressure system, and to its pushing back

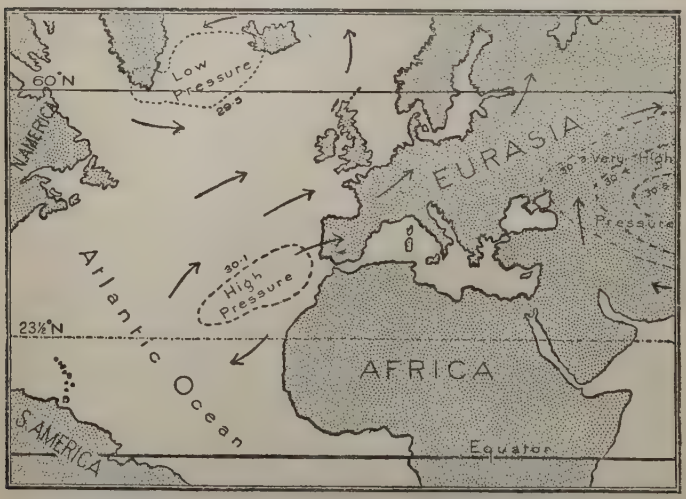


FIG. 47.—THE "PRESSURE SYSTEMS."

Which cause the prevalent winds of the British Isles in January; very high pressure in Mid-Asia; high pressure in the Azores region; low pressure in the Icelandic region.

the Atlantic low-pressure systems. The influence of the ocean asserts itself as the spring advances and as the Eurasian high-pressure condition is gradually replaced by the summer low-pressure condition.

British Rainfall.—From the consideration of the winds we pass to the rainfall, which depends so much and so directly on the winds. The prevalent winds blow from over a warm ocean; they therefore come to Britain warm and containing much moisture. They meet the British western highlands athwart their direction; these highlands they have to surmount.

As the air passes into higher regions there is a lowering of pressure, and consequently expansion ; this in turn causes cooling ; condensation of water-vapour follows, and much rain falls. Thus the western, mountainous parts of the British Isles are wet, and most of the higher mountain regions have a rainfall of 60 inches or more per annum.

As the rain-bearing winds descend into lower regions on the other side of the mountains the moving air is compressed and warmed, and thus becomes relatively drier ; and the consequence is that less rain falls. Districts under the lee of mountains are said to be in a **" rain-shadow."** Good examples are the Somersetshire lowlands under the lee of Dartmoor, Exmoor, the Brendon and Quantock Hills ; the Herefordshire plain under the lee of the Black Hills and Brecknock Beacons ; the lowlands of North Wales and Cheshire under the shelter of the Snowdon group of mountains ; the Nottingham-Yorkshire plain behind the Pennines; and the sheltered villages of the Don and Dee in the Highlands, protected by the great granite massif of the Cairngorm group.

Three interesting cases may be studied in more detail : (*a*) The **Herefordshire fruit-growing plain.** The Black Mountains and Brecknock Beacons have a rainfall up to 60 inches ; the plain of Herefordshire has a rainfall in places of only 30 inches. Of course, this means less cloud and more sunshine ; and this, aided by the fertile soil of the Old Red Sandstone plain, makes possible the rich fruit farms and hop gardens of the district. (*b*) Rhyl, in the far north of Wales, advertises itself as **" Sunny Rhyl,"** and it is not an empty boast. Snowdonia has a rainfall of over 100 inches ; Rhyl is in the rain-shadow, and the amount of rain and cloud diminishes rapidly towards the north-east, until at Rhyl the rainfall is not more than 30 inches. Some parts of the Wirral Peninsula across the estuary have an average of less than 30 inches per annum. (*c*) The **Grampians** have a heavy rainfall, and, as may be expected, this rapidly diminishes towards the

east. The valleys of the Don and Dee are in the rain-shadow. This partly accounts for the popularity of **Braemar** and other

FIG. 48.—RAINFALL MAP OF THE BRITISH ISLES.

places, where summer and autumn sunshine are combined with a cool and bracing air.

In dealing with the rainfall of a region it is important to note not only the quantity but the seasons in which it falls. That of Britain is remarkable in being distributed so equally over all the seasons. Here follows a short table taken from the author's *The Groundwork of Modern Geography*, the rainfall of each season being expressed as percentages of the annual rainfall :—

	Winter.	Spring.	Summer.	Autumn.
Ireland . . .	28	21	24	27
West of England .	28	19	24	29
East of England .	23	19	28	30

It will be seen from this table that there is some difference between the eastern and western parts of Britain, but nothing like the seasonal difference experienced in the Mediterranean, for example. The more continental east shows its continental character by having the heaviest summer rainfall ; the oceanic west has a slightly wetter winter, as may be expected. It will, of course, be remembered that the total rainfall in the east is little more than half that of the western districts generally ; thus the winter rainfall of the east would be 23 per cent. of about 25 inches ; that of the west would be 28 per cent. of about 50 inches. It should be noted, too, that spring is the driest season in the British Isles generally.

British Temperature.—Temperature now demands attention ; and this may well come last, as it is so largely dependent on winds and rainfall. It is important to remember that the average temperature of these islands is higher than that of other regions in the same latitude and situated on the edge of the continent. There are three regions with which comparison may fairly be made—British Columbia, Labrador, and Kamchatka.

The average January and July temperatures of these regions are here given.

	Average Latitude.	Jan. Temp.	July Temp.
British Isles . .	55° N.	40°	60°
Charlotte Islands, British Columbia .	55° N.	36°	58°
Labrador . .	55° N.	0°	46°
Kamchatka . .	55° N.	5°	52°

The relative warmth of the British Isles both in summer and in winter is obvious from these figures.

An **isothermal map** of Britain is worth very careful study, for these lines of equal average temperature teach us at a glance a great deal about our climate.

The January isotherms of 38°, 40°, 42° F. and the July isotherms of 58°, 60°, 62° F. will serve our purpose. These are shown on the map, fig. 49.[1] Note that the **winter isotherms** run on the whole from north to south, the medium one, 40° F., particularly so. This, of course, means that the west is warmer than the east in winter ; the warmth of the Atlantic is brought to the land by warm winds and warm rains, and the temperature of the west is thus raised more than that of the east. The January temperature of the Orkneys, the Isle of Man, the Isle of Anglesea, and the Isle of Wight is almost the same, a fact which surprises most people who have not studied this phase of geography.

The west and south-west have average January temperatures of 42° F. or more, which is simply another way of expressing the well-known mild winter climate of Cornwall, the Scilly Isles, and the west of Ireland. The extreme south-west of Cornwall is about 8° F. warmer in January than the Fenlands round the Wash.

The **July isotherms** run on the whole east and west, and

[1] Temperatures are reduced to sea-level. Allowance must of course be made for altitude in using such an isothermal map.

again the medium one, 60° F., may be more especially studied. It runs through southern Ireland, the Irish Sea, and the north

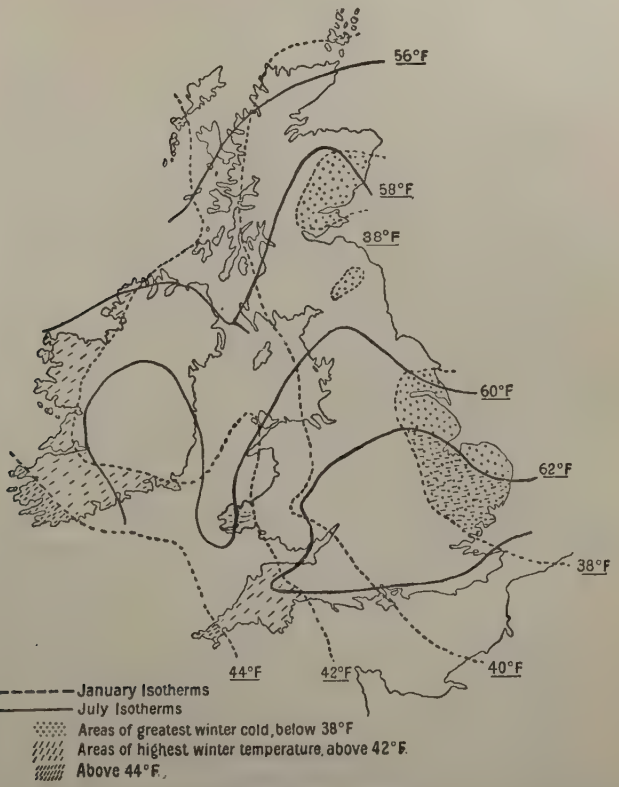


FIG. 49.—THE DISTRIBUTION OF TEMPERATURE AT SEA-LEVEL IN THE BRITISH ISLES.

Note the region in the Eastern Midlands with January temperature below 38° F., and July temperature above 62° F. This is the region of greatest extremes in Britain, the range being over 24° F. There is a very small region in the north-west of Ireland where the January temperature is above 42° F., and the July temperature is *below* 58° F., the range being below 16° F.

of England, twice bending northward over the land and southward over the intermediate Irish Sea. On the whole, there-

fore, average July temperature diminishes from south to north, and as an example the Orkneys are about 6° F. cooler in July than the Isle of Wight.

If we take the January isotherm [1] of 40° F., and the July isotherm of 60° F., and leave the others out of consideration for the moment, we may thus divide the British Isles into four "climatic provinces"; these may be traced on the map, fig. 49.

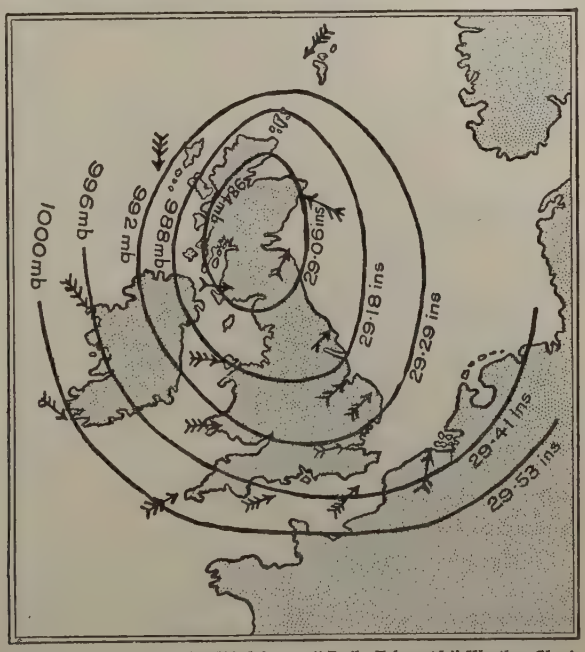
Reverting again to the map, fig. 49, the shaded areas in the south-east of England and the north-west of Ireland should be carefully noted. The former marks the area where the British climate is most extreme; the latter where it is least extreme.

Some Weather Conditions.—In most of the preceding study we have dealt with climate—that is, with the average weather conditions over a series of seasons. We will now describe two contrasted types of **weather** that are of frequent occurrence over the British Isles. Both are best represented on maps by using **isobars** —that is, lines of equal barometric pressure. The first is the **cyclone,**[2] in which there is an area of low pressure in the centre of the system, and a gradual increase outward. The isobars are concentric, with the one showing the lowest pressure forming a closed area in the middle. In obedience to ordinary laws of gases, air will flow from the outer high-pressure regions towards the low-pressure centre; but owing to the earth's rotation the direction of the inflowing winds is not at right angles to the isobars, but to the right of this direction. Such a cyclonic system was over the British Isles on 26th to 29th August 1920.

Cyclones are usually associated with rain. The inswirl of air towards the centre must be compensated by rising air in the middle of the system. This air on rising expands, is cooled, and rain falls in consequence. Especially is the south-

[1] See note on p. 136.
[2] Usually called a "depression" or "low" in this country.

eastern quadrant of an average cyclone usually associated with rain, because the south-westerly warm, wet winds are blowing from the warmer to the cooler regions, and from a warm ocean.



Simplified from a "Daily Telegraph" Weather Chart.

FIG. 50.—DIAGRAM OF A CYCLONE PRESSURE SYSTEM

Which was over the British Isles on Aug. 29, 1920. The isobars, or lines of equal barometric pressure, show an *increase* of pressure from the centre of the system outwards. One thousand millebars are equal to 29·53 ins. The direction of the winds is shown by arrows; the strength of the winds by the number of barbs on the arrows.

Cyclones pass across the British Isles frequently, and as a rule rather rapidly. They follow certain well-marked paths on the whole. The general direction of transition of cyclones is such that Britain frequently gets the south-eastern rainy quadrant. This is another reason why rains are so frequently associated with south-westerly winds.

The other common type of weather conditions is the **anticyclone.**[1] In this there is high pressure in the centre and a decrease outwards. The isobars are not so near together as in the cyclone, as a rule ; or, in other words, the pressure does

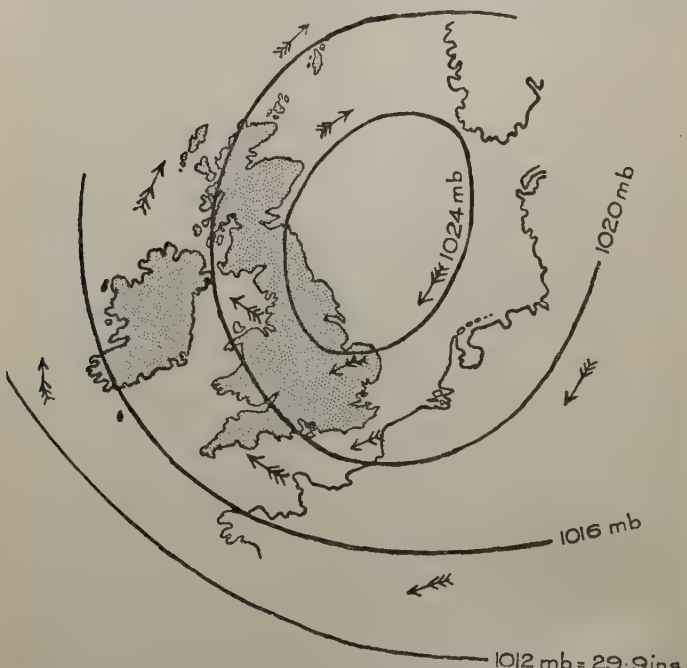


FIG. 51.—ANTICYCLONE PRESSURE SYSTEM.

The isobars show that the pressure *decreases* outwards. Compare the winds with those shown in the cyclone (fig. 50) in direction and force.

not diminish so rapidly as it increases outwards in the cyclone. Air flows outwards from the high-pressure centre, but again not in a direction at right angles to the isobars but to the right of that direction. There is a downflow of air in the middle of the anticyclone to supply the outflow which is always going on. This descending air is compressed and warmed, and its capacity for moisture is increased ; hence there is usually fine, dry

[1] Sometimes called a "high" in this country.

weather. In winter there is generally keen frost, and there may be fog in the lower parts of valleys where the air is still; in summer there is fine, warm weather.

Anticyclones do not travel so rapidly as cyclones; on the other hand, they are sometimes remarkably stable for days or even weeks. They occur much less frequently than cyclones, as mentioned already: cyclones come at the rate of about forty a year on the average; the number of anticyclones is rarely more than about a dozen.

CHAPTER XI

THE PRODUCE OF THE LAND AND THE SEA

AGRICULTURE AND FISHERIES

Food is the first need of a people, and its supply in sufficient quantity and variety is a most important consideration. During the last century or so Britain had enjoyed such unexampled commercial prosperity, and had made so much wealth by the manufacture of things other than food, that the production of the latter had fallen quite into the background. The idea had grown, perhaps quite unconsciously, that British agriculture was of little importance in the life of the nation, as the food supply could be drawn from the whole world. The United Kingdom does not produce nearly sufficient food for its people. In 1933 food to the value of about £320,000,000 was imported into Great Britain alone—this amount not including spirits, wine, or tobacco. The values of the imports of a few important foods and foodstuffs were approximately as follows:—

Wheat and wheat flour	£52,000,000
Maize and maize meal and flour	13,000,000
Meats, poultry, etc.	94,000,000
Butter, margarine, cheese, milk, etc.	62,000,000
Fruits	18,000,000
Sugar	25,000,000

These figures [1] represent the values at the port of entry;

[1] Some of the figures given in this and the next three chapters may vary from year to year. The latest returns can be obtained from the current issues of *Whitaker's Almanack* and the *Statesman's Year Book*.

the prices paid by the consumer would obviously be very much higher than these figures. Looking at the matter from another point of view, the people of Great Britain paid in 1933 about £8 per head at the ports, or over 3s. per head per week. From these figures it will be seen to what extent Britain had become dependent on the rest of the world for its food supplies.

During the last fifty years 4 million acres have passed from ploughed land to grass, which is said to represent a loss of employment for 300,000 men. Arable land yields twice the produce in money value and three to five times the food value compared with grass land. It is no wonder, therefore, that the United Kingdom produces only **one-fifth** of the necessary **wheat** and less than one-third of all the foods required.

There was, however, a great increase of food production in the United Kingdom during the later years of the Great War. This was a case of sheer necessity, and it is now agreed that the production of food should be increased and maintained at a high level by the intelligent use of artificial manures and fertilisers, by the use of remedial measures against plant and animal diseases, by making the best use of land that had been allowed to do very little in the days of intensive manufacture, and by the spread of agricultural education.

Cultivation of Cereals.—Three chief cereals—**wheat, barley,** and **oats**—are cultivated in the British Isles. The amount of rye is small and that of maize negligible. The latter does not ripen in Britain, and is only grown to a trifling extent as a green-fodder crop.

Oats is the biggest crop, the amount in 1933 being nearly equal to barley and wheat combined. In 1917, towards the end of the Great War, the acreage under oats was greater than that under wheat and barley combined. The following table summarises the position:—

Total acres in Great Britain . .	56,400,000
Acres of arable or ploughed land .	13,000,000
,, under oats in 1933 . . .	2,350,000
,, ,, wheat	1,740,000
,, ,, barley	850,000

The preponderance of oats is due to the general damp climate and the relatively small amount of sunshine in the British Isles. This is the one cereal which is grown in nearly all parts, except on the higher hills. Rain is not so fatal to it as to the other cereals, and it will ripen with less sunshine.

Wheat requires a fairly dry summer, with a good deal of sunshine; and these conditions are not realised in most of Ireland, nor in much of the west of England, and only in parts of the east of Scotland. Hence the great wheat-growing area is in the south-eastern Midlands and in East Anglia, where the conditions are more favourable. Of course, some wheat is grown in other districts, among which may be mentioned the Plain of Yorkshire, the Merse (the lower valley of the Tweed), and parts of the eastern Lothians of Central Scotland. In the last-named region farming is so intensive that the yield per acre is greater than anywhere else in the British Isles.

About nine-tenths of the wheat of the British Isles is produced in south-eastern England. **Barley** is much more widely spread than wheat, but it is also more successful in eastern Britain, especially in the Yorkshire Plain and in the Vale of Pickering.

Root Crops and Potatoes.—The cultivation of these is very widely spread, but again the eastern counties of England and the Lowlands yield the best crops. **Turnips** are widely grown as winter fodder for cattle and sheep, as well as for human food. The area under these was almost equal to that under barley in 1933. The distribution of **potatoes** is interesting.

Before the war, Ireland produced as many potatoes as the whole of Great Britain, and by far the greatest contributor was Ulster. Of course, the production was increased enormously during the war; and it is to be hoped the increase will be maintained, not only because potatoes are an important food, but also because starch can be obtained from them, and, indirectly, alcohol for industrial purposes. For the latter purpose it is likely to be wanted in increasing quantities, and in the past the United Kingdom has been almost entirely dependent on foreign supplies.

Another important root-crop is the **sugar-beet.** The climate and soil of the British Isles are said to be as suitable as those of Belgium and Germany, where very large quantities have been grown. East Anglia, the Yorkshire Plain, and other parts have proved to be suitable in both soil and climate. Half-a-million tons of sugar were obtained in 1933 from the sugar-beet grown in these areas.

Peas and Beans.—These are, of course, grown in market gardens, but also in larger quantities in such districts as the reclaimed fen-lands of the Wash and the Humber. About 290,000 acres were under these crops in Great Britain in 1933.

Fruits.—These also are very widely spread, but certain regions are famous for certain fruits. Kent is the greatest fruit-growing county, producing **strawberries, apples, plums,** and **pears.** It had, in 1933, about one-fourth of the orchards in England and Wales. **Strawberries** are also grown in Hampshire, Cambridgeshire, Cheshire, on the Yorkshire Plain, and on Strathmore. The latter plain and the Carse of Gowrie are also famous for **raspberries,** and probably more are grown there than anywhere else in the British Isles. A belt of country which is celebrated for its **apples** and **pears** runs from Herefordshire through West Gloucestershire and Somersetshire into Devonshire. Great quantities of **plums** are also produced in this fruit-growing belt. Hertfordshire, Bedfordshire, and Buckinghamshire produce large quantities of

apples and **plums.** **Gooseberries** and red and black **currants** are grown in almost all parts of the United Kingdom.

Kent and Herefordshire grow almost all the **hops** of Britain. Another localised crop of quite a different kind is **flax,** which is practically confined to the north-eastern corner of Ireland and to certain parts of the Midlands and east of Scotland.

Grass and Hay.—More than one-half of the enclosed land in England was under grass in 1933, and about three-quarters of Wales, Scotland, and Ireland. Grass for pasture and for hay is the best crop where there is a good deal of rain at all seasons of the year. Hence the west—that is, the wetter side—is essentially the grass region of the British Isles.

Cattle are reared for beef and for milk, and for the butter and cheese from the latter. Such a county as Kent has relatively few cattle, as may be expected, the number being about one-fourth that of Cheshire. Noted cattle districts are the following: the south-western peninsula, the Pembroke peninsula, Anglesea, and the lowlands of Caernarvon, Cheshire, south Derbyshire, and the adjoining parts of Staffordshire and Leicestershire, the Craven lowlands, the extreme south-west of Scotland, the peninsula of Fife, and the central plain of Ireland. (See fig. 52.)

Sheep.—These were very important in the Middle Ages, and **wool** was then the greatest export of Britain. The Lord Chancellor sits on a "woolsack" in the House of Lords: this is a relic of the times when the King derived much of his revenue from duties on exported wool. Great Britain has now about 24,000,000 sheep and Ireland about 4,000,000. Sheep are most numerous in the following regions: the Chalk and Jurassic uplands, the Welsh hills, the Pennines, the Cheviots, and the southern uplands of Scotland. The wool from the sheep of the Berkshire downs and the Marlborough downs was the foundation of the woollen factory of Jack of Newbury in the time of Queen Elizabeth; the sheep of Salisbury Plain and the Cotswolds are among the factors

explaining the **West of England** woollen industry, located at Bradford-on-Avon, Frome, and Stroud; the sheep of the

FIG. 52.—DISTRIBUTION OF CATTLE AND SHEEP IN THE BRITISH ISLES.

a=Chief cattle regions. *b*=Chief sheep regions.

Northampton heights explain the old wool-market at **Leicester**; the Welsh sheep of Merioneth and the central hills of Wales laid the foundation of the woollen industry of **Newtown** and

Welshpool; the sheep of the Pennines provided the raw material for the early woollen mills of the Yorkshire dales, and thus started the vast woollen industry of the **West Riding**; the sheep of Peebles, Roxburgh, and Berwick explain the **tweed cloth** industry of Galashiels and Hawick district.

Pigs are not so important as they were in the early Middle Ages, when forests covered a greater part of the surface of the country, and when the swineherds fed their pigs on the plentiful nuts of the forests. Ireland was formerly ahead of England in the relative number of its pigs, and still more ahead of Scotland. In 1933 England and Wales had made progress, and had 3,000,000 pigs to 1,200,000 in Ireland; while in that year Scotland had 170,000, or about one-seventh of the number of Ireland. All these numbers went down in 1916–1917, but there has been a recovery since the end of the Great War.

Horses.—Horse-rearing is important in the western and northern parts of England, in the south-west of Scotland, and in the less boggy parts of Ireland. In 1933 there were about 1,700,000 horses in the British Isles, of which a little over a quarter of the number were in Ireland. The approximate numbers in 1933 were: England and Wales, 1,000,000; Scotland, 150,000; Ireland, 500,000. It is important to note that Ireland is well ahead of Scotland in the number of horses.

Dairy-Farming.—This is here taken as including farms where **milk, butter, cheese,** and **eggs** are the principal products. Some of the larger dairy-farms produce the whole of these, but usually farmers restrict themselves to two or three. In the vicinity of large towns and great industrial communities milk and eggs are the more important, and usually pay the small dairy-farmer best; in the remoter dairy-farming districts butter and cheese are more important productions. Dairy-farming, like many other branches of industry, was very much recast owing to the Great War, but certain districts

still specialise in butter or cheese; for example, parts of Derbyshire, Somersetshire, Cheshire, north Lancashire, Wharfedale, Wensleydale, and Swaledale are noted for cheese. In Wensleydale old woollen mills have recently been converted into co-operative cheese-making factories for the farmers of the dale. The production of eggs in Britain has assumed an importance altogether undreamt-of before the Great War; whether the interest will be maintained remains to be seen. Poultry-farming, especially near the great industrial regions, is now a flourishing and lucrative industry. The United Kingdom imported £13,000,000 worth of eggs in 1933.

Allotments and Small Holdings.—During the last few years there has been a great increase in the number of allotments and small holdings. Almost every town and village has now its small-holders' or allotment-holders' association. Almost every type of school and college has its vegetable and fruit garden, and the students gain in many ways: they learn a good deal about the difficulties and the pleasures of gardening; they acquire a first-hand knowledge of soils, of the processes of plant-growth, and of practical botany; they work in the open air; and they contribute somewhat to the food supplies of the country.

Forestry.—Until quite recently systematic forestry has received very little attention in the United Kingdom, and effective Government help has been very limited. Hence the British Isles are far behind some continental countries in the relative area under forests and in the value of timber derived from them. During the Great War many fine forests had to be sacrificed to supply some part of the timber which had usually come from abroad. In consequence of this a Government sub-committee recommended that there should be a national policy of afforestation, and a special committee was set up for this purpose in 1918.

The counties of Dorsetshire, Hampshire, Sussex, and Kent

are the best wooded regions in Britain. There are other districts, such as the " Dukeries " and the valley of the Wye, which are beautifully wooded. There are large forests in Aberdeenshire and Inverness-shire. Many pine forests have been planted in comparatively recent years in Scotland, in the Pennines, on the Welsh hills, and on Exmoor. Some reclaimed coastal lands have been planted with the maritime pine (*Pinus maritima*) to help in the complete reclamation of the land and to get from it a quicker return. British forestry is yet in its infancy, however, but there are signs that it will receive more attention in the future.

Though there are comparatively few large forests, there is probably no European country in which trees are more equally distributed. Small spinneys and coppices are exceedingly numerous, and these, together with scattered trees in parks and in hedgerows, make up a considerable body of timber.

These sources should be cared for, conserved, and increased so as to save our other fuel supplies, and to furnish timber for many purposes.

FISHERIES

The seas round the British Isles are shallow, especially those to the east and south, and between the island groups. Shallow seas in cool-temperate climates are always good fishing-grounds, more especially when numerous rivers bring down large quantities of land debris of various kinds.

The temperature, the saltiness, the shallowness of the seas, the sweeping action of the tides, all combine to make the British seas among the best fishing-grounds in the world. Fish, therefore, forms a considerable and most valuable food supply for the British people. There is a hardy race of fishermen, whose fleets go out from many ports. In addition to the old-time fishing-boats, steam trawlers now bring in large quantities. The chief fishing stations and ports are:

Lowestoft, Yarmouth, Grimsby, Hull, Leith, Dundee, Aberdeen, Fraserburgh, Peterhead, Wick, Thurso, Lerwick, Stornoway, Whitehaven, Peel, Fleetwood, Belfast, Dublin, Milford, Tenby, St Ives, Penzance, Brixham, and Plymouth. The chief trawling centres are Grimsby, Aberdeen, Fleetwood, and Plymouth.

Cod, ling, haddock, sole, plaice, and herring are well-known and important food fishes, of which large quantities are caught around the coasts of the British Isles.

The value of the fish landed on the coasts in 1933 by British fishermen was about £15,000,000. 4,500,000 cwts. of herrings were landed in the fishing ports of the British Isles in 1933, valued at about 8s. 3d. a cwt. The herring, it should be pointed out, possesses the highest food value among common fishes, and forms a very cheap food.

CHAPTER XII

MINERALS AND ROCKS

We have learnt that the British Isles contain a great variety of rocks. The wealth of rocks and minerals has certainly been an important factor in giving to Britain its eminent position in the industrial world.

Undoubtedly the most important rock-mineral is **coal**, which we will take first. The use of coal as fuel has been known for many hundred years, but it is only within the last two centuries that it has come to play a very important part in the national life. The chief uses of coal are the following :—

(*a*) For warming our homes and public buildings.

(*b*) For producing mechanical and electrical power through steam.

(*c*) In furnaces where iron or other metals are smelted.

(*d*) For making coal-gas.

From (*c*) and (*d*) many important by-products are obtained, which will be referred to later.

Practically all British coals are obtained from the Carboniferous system, where it occurs in layers or seams varying from a few inches to five or six feet in thickness. These seams are interbedded in a thick series of sandstones, shales, and clays—the whole, with the coal seams, forming the **Coal Measures.**

A region where these Coal Measures occupy the surface of the land is known as a **coal-field.** One important point needs careful explanation. In many parts of Britain the Coal Measures are covered by newer rocks, especially by the rocks

of the New Red Sandstone systems. If these overlying rocks are not too thick it is often worth while to sink a shaft through them to reach the underlying Coal Measures. For example,

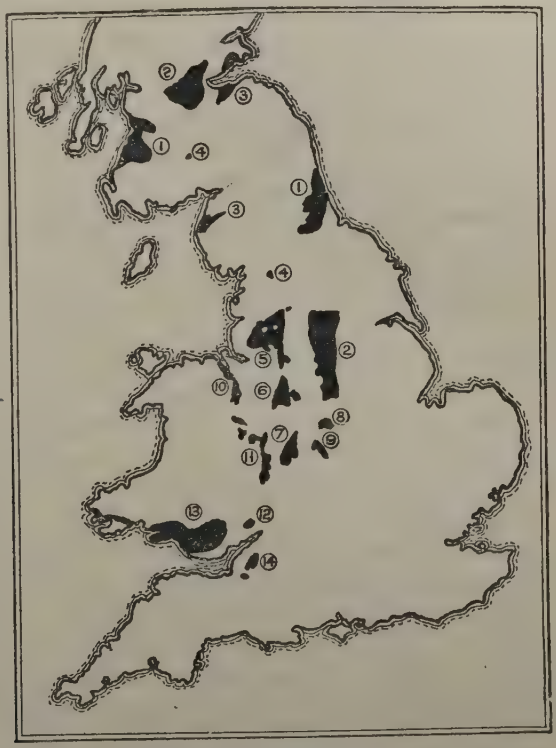


FIG. 53.—EXPOSED COAL-FIELDS OF GREAT BRITAIN.
(For names see p. 154.)

there is a good deal of coal-mining on the North-eastern Plain. From Nottingham, northward through Mansfield and Worksop to Doncaster, there are many coal-pits thus situated. **Doncaster,** now a great coal exchange, is not on a coal-field, as may be seen from a geological map ; and Mansfield and Worksop are similar towns situated some miles from

the edge of the coal-field. The borings for coal in Kent had to pass through a great thickness of newer rocks before reaching the underlying Coal Measures, the existence of which had been indicated by geologists more than half a century ago.

The coal-fields of Great Britain are the following :—

Scotland :—

1. West Lowlands, in Ayrshire.
2. Central Lowlands, in the counties of Lanark, Renfrew, Stirling, and Clackmannan.
3. East Lowlands, in the counties of Edinburgh, Haddington, and Fifeshire.
4. The small Sanquhar coal-field in the Southern Uplands, in Dumfriesshire.

England and Wales :—

1. Northumberland and Durham.
2. Yorkshire, Derbyshire, and Nottinghamshire.
3. West Cumberland.
4. The small Ingleton coal-field.
5. Lancashire and Cheshire.
6. North Staffordshire.
7. South Staffordshire or Cannock Chase, in South Staffordshire and Worcestershire.
8. Leicestershire or Ashby.
9. Warwickshire or Tamworth.
10. North Wales, in the counties of Flint, Denbigh, and Shropshire.
11. Mid-Severn, in Shropshire and Worcestershire.
12. Forest of Dean, in Gloucestershire.
13. South Wales and Monmouth: in Monmouth, Glamorgan, Caermarthen, and Pembroke.
14. Bristol, in South Gloucestershire and Somersetshire.

See map, fig. 53, which shows the actual coal-fields, and not the buried Coal Measures.

The coal-mining industry was thoroughly dislocated by the war and by the labour troubles which have followed it, but it is hoped that things have now settled down. The amount of coal raised in 1933 was 208,000,000 tons, valued at the pits at £134,600,000—that is, about 13s. per ton. The amounts mined in the principal coal-fields were:—

1. The three Scottish Lowlands coal-fields: 28,680,000 tons, or 14 per cent.
2. The Northumberland and Durham coal-field: 41,800,000 tons, or 20 per cent.
3. The Yorkshire, Derbyshire, and Nottinghamshire coal-field: 69,000,000 tons, or 33 per cent.
4. The Lancashire coal-field with North Wales: 16,560,000 tons, or 8 per cent.
5. The South Wales and Monmouthshire coal-field: 37,260,000 tons, or 18 per cent.

The amount for Ireland is almost a negligible quantity, being less than 1/2000th part of the whole for the British Isles.

Of the 208,000,000 tons mentioned above, about 42,600,000 tons were exported either as coal or as coke; that is, about one-fifth of the whole. The greatest exporting coal-fields were those of Northumberland and Durham and South Wales. The former exported from the **Tyne** ports, **Sunderland, Blyth,** and **Seaham Harbour,** about 14,500,000 tons; from **Newport, Cardiff,** and **Swansea** about 17,000,000 tons were shipped abroad. Cardiff exported more than any other British port. Other ports which sent out 1,000,000 tons or more were Hull, Grimsby, Burntisland, Leith, and Grangemouth.

The countries to which the coal was exported in order of amount received were: France, Italy, Germany, the countries of South America, Egypt, Spain, Denmark, Sweden, and Holland, with small amounts to other countries. France

took 7,000,000 tons, valued at £5,500,000. Over 800,000 persons were employed in coal-mining in Great Britain in somewhat under 2500 coal-mines.

A large quantity of coal is converted into **coke** for iron smelting, and stacks of " coke-ovens " may be seen on most of the coal-fields. In some coking-plants the gases set free from the " roasting " are condensed, and many important by-products such as **coal-tar oils** and **ammonia** are obtained; in many others no attempt is made to recover these products. **Durham** is the greatest coking district, and produces over one-third of the 12,000,000 tons of coke fuel made in the British Isles. Other important coke-producing districts are South-west Yorkshire, Derbyshire, and South Wales.

Other Fuels.—Peat. This is very widely spread in various parts of the British Isles. The chief regions where it is obtained for fuel are: many parts of Ireland, Dartmoor, the Welsh hills, the peat mosses of South-west Lancashire and Cheshire, the Pennine Moorlands, the Southern Uplands of Scotland, and the Highlands of Scotland. It is cut up into slabs, dried outdoor, and stacked. It leaves a good deal of ash on being burnt. Peat has been cut and dried for fuel on a greatly increased scale during the last few years owing to the high price of coal.

Oil Shales.—Paraffins are obtained by the distillation of Carboniferous shales in the eastern half of the Central Lowlands of Scotland, chiefly in the county of Linlithgow, with Broxburn as the centre of the district. The oil shales are heated in specially constructed retorts, and the gases are condensed.

In addition to solvent and burning oils and wax, large quantities of **ammonia** are obtained in this way. The amount of oil shales used in 1933 was about 1½ million tons, valued at about £400,000; this industry has declined considerably in recent years.

Oil from Borings.—Small quantities of oil have from time to time been obtained from the Coal Measures of East Derbyshire. At Alfreton in that county oil was obtained many years ago. Quite recently deep borings have been put down and a considerable amount of money spent in an attempt to obtain petroleum. The search for other sources of heat and mechanical power will certainly continue. Coal has been one of the foundations of Britain's industrial supremacy, and it is doubtful if the former quantities will ever be produced again; and in any case, the price seems likely to remain very high.

Iron Ores.—Next to coal, the most important minerals are the iron ores, of which the British Isles yield considerable supplies. Iron ores are found in the British Isles chiefly in the rocks of the Carboniferous and Jurassic systems. **Hematite,** or kidney iron ore, is found in pockets and veins in the Carboniferous Limestone. This ore is obtained from the limestone of North Wales and the Forest of Dean, but the chief source is the limestone rim which surrounds the older rocks of the Lake District. On the southern side, at Ulverston, Dalton, Askam, and Millom, and on the northern side, in the Cleator Moor district, hematite is obtained in large quantities. This ore is the richest in the British Isles, often containing more than 50 per cent. of metal. About $\frac{3}{4}$ million tons of this ore were raised in 1933. The iron furnaces of Carnforth, Dalton, Barrow, Millom, and of the West Cumberland coal-field owe their existence to these supplies of ore, though the local supplies are now supplemented by ores imported from Spain, Greece, Norway, Sweden, and Labrador. There are many blast furnaces for smelting iron in West Cumberland and the Furness part of Lancashire.

The **blackband ironstone** and the **clay ironstone** of the Coal Measures constitute another important source of ore. These occur in nodules and irregular bands among the shales of the Coal Measures, and large quantities are obtained

from Lanarkshire, South Yorkshire, Derbyshire, South Staffordshire, and South Wales. The occurrence of the ore and the coal close together is very important. There are many iron furnaces on these coal-fields in consequence; but again local supplies are supplemented by imports. **South Staffordshire** once led the iron-smelting districts in the number of furnaces, but this is no longer the case.

Another very important supply comes from the various rocks of the Jurassic and Lower Cretaceous. The chief localities are: the Cleveland district of North-east Yorkshire, Lincolnshire, Leicestershire, Northamptonshire, Oxfordshire, and Wiltshire. In Cleveland the iron ore is largely worked by underground mining. **Middlesbrough** obviously owes its great iron-smelting and steel-making industries to this supply of ore; but again imports are added to local supplies. In Lincolnshire and the Midlands the **brown iron ore** is obtained chiefly by open working or quarrying. The Jurassic rocks yielded over three-quarters of the $7\frac{1}{2}$ million tons of ore raised in the British Isles in 1933. North-east Yorkshire supplied about one-fourth of the whole.

Comparatively small supplies of iron ore are obtained from near Brixham and Hey Tor in Devonshire, the Brendon Hills in West Somersetshire, and from the volcanic rocks of Antrim.

In 1933 about 7,500,000 tons were obtained in the British Isles, and about 2,700,000 tons were imported. To smelt this 10,200,000 tons of ore it required over 8,000,000 tons of coal or coal converted into coke.

Other Metallic Ores.—The British Isles yield a great variety of ores other than iron, and some in considerable quantities. The rocks of Cornwall and Devonshire, Wales, and the Pennines, the Lake District, the Southern Uplands of Scotland, the Isle of Man, and the Wicklow Hills are the chief regions where these metallic ores are obtained.

In addition to the ores of metals there are other minerals of value found in the mineral veins; among these are **fluor, barytes,** and **witherite. Kaolin**—or china clay—is another

FIG. 54.—IRON ORE DISTRICTS OF BRITAIN.

Key.—*a*, Mesozoic Ores. *b*, Carboniferous Limestone (Hematite). *c*. Clay Ironstone and Black-band Ironstone of the Coal Measures. *d*. Other ores.

mineral which occurs in very large deposits in the granite regions of Cornwall and Devonshire.

It has been formed by the natural decomposition of the granite of the district.

The following is a brief summary of the metallic ores

and other minerals from some of the more important districts :—

Cornwall and Devon.—Ores of tin, copper, bismuth, arsenic, antimony, and tungsten. The Cornish ores of tin were known some centuries before the Christian era.

South Wales, Central Wales, and North Wales.—Ores of lead, zinc, copper, and manganese, and a little gold. Barytes is obtained both in Wales and in Shropshire on the Welsh border.

The Pennines.—Ores of lead and zinc, more especially the former, with large quantities of barytes and fluor. Derbyshire and Alston Moor and Weardale furnish much fluor. Derbyshire, Wharfedale, and Lunedale supply a good deal of barytes.

The Lake District.—Ores of copper, lead, and tungsten; and in the Carrock Fell district a good deal of barytes has been obtained.

The Southern Uplands of Scotland.—Ores of lead and zinc, with much barytes. (The Lowther Hills are frequently called the Lead Hills.)

The Isle of Man.—Ores of lead with silver at Laxey and Foxdale; and the Wicklow Hills have exactly similar ores. Some gold is also found in the Wicklows.

The British Isles produced in 1933 metallic ores and associated minerals valued approximately as follows: tin, £272,000; lead, £303,000; zinc (1932), £400; copper, £812; silver, £2800; gold, £476; barytes, £110,000; fluor, £23,000.

Other Minerals and Rocks.—*Salt*, common salt, or sodium chloride. This is obtained as rock salt from the New Red Sandstone marls of Cheshire, North Lancashire, and near Larne. It is obtained in larger quantities from " brine " in Cheshire, Worcestershire, and near Middlesbrough. Water is forced down into the salt-bearing beds and the saturated brine is pumped up. Over 2,000,000 tons

of salt were produced in 1933. It is important as a food-adjunct, and is also the chief material in some very

FIG. 55.—DISTRIBUTION OF LEAD, ZINC, COPPER, AND TIN.

Key.—Pb, Lead; Zn, Zinc; Cu, Copper; Sn, Tin. The chief districts where common salt is obtained are shown as "a" at the foot of the diagram.

important chemical industries which will be mentioned in a later chapter.

Gypsum is obtained from many clays, and especially from the marls of the New Red Sandstone of Cumberland, Cheshire, Derbyshire, Nottinghamshire, and Durham. By carefully heating it to drive off water, **"Plaster of Paris"**

is obtained. Nearly a million tons of gypsum were quarried in England in 1933.

Flint occurs in nodules in the Chalk. It is used in the manufacture of **glass** and **porcelain,** and over 175,000 tons of flint and chert were obtained for these purposes in 1933. The Chalk escarpment from Flamborough to the south of England yields flints in many places. At Brandon, near Norwich, is an important series of pits in the Chalk, from which **gun-flints** have long been obtained.

Clays.—These are obtained from many geological systems, and from many districts. Pottery, bricks, and tiles are made from them. The well-known "**Potteries**" in North Staffordshire, of course, stand out as the most important district, using not only local clay and shale, but importing a good deal of kaolin from Cornwall and Devonshire.

Pottery manufacture is also carried on in South London, Derby, and near Wigan. Bricks, tiles, and various bulky articles of sanitary ware are made at Wortley near Leeds, at Accrington and Burnley in North-east Lancashire, in the Wigan district, at Ruabon, and in the Glasgow district, among other places. The London Clay has been used in enormous quantities for making bricks.

Fireclay is a special clay, almost free from alkalies (potash and soda), and does not readily fuse on heating. From it are made crucibles, fire-bricks, retorts, and other articles which have to be very strongly heated. It is obtained from the Coal Measures in many parts of the British Isles. Stourbridge in Worcestershire is a famous locality.

Limestone is roasted ("burnt") in kilns: carbon dioxide is driven off and lime ("quicklime") is left. Formerly this process was carried on in small kilns which were scattered all over the country wherever limestone is found. Now large iron kilns are erected and the small kilns have almost passed out of use. The large kilns are found in many limestone districts—the Mendips, South Wales, North Derbyshire,

Central Derbyshire, and the Northern Pennines. Lime is used in many chemical industries, among which are the manufacture of caustic soda, bleaching powder, and chlorate of potash. It is also used in leather manufacture, as a fertiliser in agriculture, and for making mortar and cement in the building trade. Lime is also made by heating chalk, which is a soft, white limestone ; and there are many lime-kilns in the Chalk regions of the south and the east of England.

Building Stones.—Broadly speaking, dwelling-houses are built of stone in the hilly regions and of brick in the lowlands. In Wales, the Pennines, and in the Southern Uplands of Scotland excellent stone-built dwellings are the rule. Most of them are built of sandstone and grit, though limestone is used occasionally. Some of the more famous places where excellent building stone is obtained are the Forest of Dean, Ludlow in Shropshire, Cradley near Malvern, Darley Dale and Glossop in Derbyshire; Halifax, Brighouse, Bramley, Queensbury, Idle, Windhill, and Bingley in Yorkshire; Rossendale, Burnley, and Nelson in East Lancashire, Runcorn on the Mersey, Penrith in Cumberland, and in many parts of the Southern Uplands. Caithness and Cromarty in the north of Scotland have long furnished famous building stones.

Ornamental building stones are obtained from the igneous rocks of the British Isles ; especially famous are the **granites** of Peterhead, Aberdeen, Criffel (S. Scotland), Shap (Westmorland), and Dartmoor. The granite of Shap Fell contains beautiful large crystals of pink felspar, and when it is polished it has a striking appearance. It may be seen in scores of public buildings in the large cities and towns. **Dartmoor granite** contains large crystals of white felspar, and it also makes a striking ornamental building stone when polished. The London reader may see many examples in the City and the West End.

Buildings are mostly roofed with one of three materials—**tiles,** tilestones or thin flagstones, and **slate.** Tiles are made

from clay, as already mentioned. The use of tilestones is now comparatively rare. Slate is a very common roofing material. The best roofing material is obtained from North Wales. Penrhyn, Llanberis, and Festiniog are well-known localities in that region. Slate is also obtained from South Wales, Devonshire, Moffat in the Southern Uplands, and Argyllshire. The pale green roofing-slate of Borrowdale in the Lake District is a hard, volcanic ash or tuff, which splits readily into thin layers, and makes a durable slate.

Paving-stones and "Road-metal."—Igneous rocks furnish the greater part of these, though hard grits and sandstones are sometimes used for paving-stones. Some localities famous for paving-stones and road-metal from igneous rocks are Aberdeen, Criffel, and Dalbeattie in S. Scotland, Threlkeld and Eskdale in the Lake District, Middleton-in-Teesdale, Penmaenmawr Pwllheli and Rhayadr in North Wales, Atherstone in Warwickshire, and many places in South Devonshire and Cornwall; also the Mourne Mountains and Wicklow Hills in Ireland. Hard sandstones and grits for paving-stones are obtained from the older rocks of Wales, Shropshire, the Pennines, and the Southern Uplands of Scotland. Hard, dark limestones from the Lower Carboniferous rocks are largely used for road metal in many parts of Derbyshire and the West Riding of Yorkshire.

Serpentine is a soft, much altered igneous rock, which is largely used in the making of various ornaments, vases, and similar ware. The most famous locality is the **Lizard,** where it is much worked. Objects made from it are offered for sale at Penzance, Helston, Falmouth, and Truro, as well as at the Lizard itself.

CHAPTER XIII

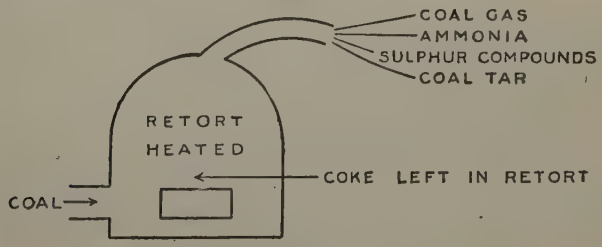
THE CHEMICAL TRADES OF THE BRITISH ISLES

So many things in modern life depend upon the applications of chemistry that a chapter is devoted to the distribution of chemical manufactures, with some mention of their influence on other trades. The study of the composition and properties of even the commoner chemicals of everyday life belongs to chemistry, but the student of Geography should know something about the location of some important chemical manufactures. These are exceedingly varied, but four groups may easily be recognised, and these are dealt with in this chapter.

(*a*) **Coal-tar Chemicals.** — So many useful and important chemicals in modern life are derived directly or indirectly from coal-tar that this group is taken first.

We learnt in Chapter XII. that large quantities of coal-tar are obtained as by-products in gas manufacture and in the production of coke for iron-smelting.

The products obtained from coal in coal-gas manufacture are shown in the following diagram :—



The coal-tar is taken from the gas-works to the tar-distiller, and there it is placed in retorts and heated. A series of products passes over at different temperatures; these are collected and worked up into an amazing variety of substances by treatment with other chemicals. These include dyes, scents, essences, photographic chemicals, antiseptics, disinfectants, medicinal chemicals, and explosives.

Coal-gas manufacture is carried on in every considerable town, and with it the production of coal-tar. Tar distillation is, however, more localised, chiefly in or near the large centres of population. London, the Birmingham district, South Lancashire, East Lancashire, the West Riding of Yorkshire, Hull, the Newcastle district, and the Glasgow district, are the chief places. Most of the chemicals produced are at once absorbed in other trades; hence the tar-distillers have their works in the great industrial regions as a rule. It is obvious that the carriage of the tar itself and of the various products will be lessened by having the works in or near those densely peopled districts.

(*b*) **Chemicals from Common Salt.**—Common salt is, as its name implies, the commonest salt occurring in nature. It is found in great quantities in the British Isles, as already mentioned (p. 160). It is a compound of two elements, sodium and chlorine, each of which is an essential constituent of some very important chemicals, as shown in the following table :—

- Common salt
  - sodium
    - caustic soda.
    - sodium carbonate or washing-soda.
    - sodium bicarbonate.
  - chlorine
    - bleaching powder.
    - " chloros " and " chlorazone."
    - chlorate of potash.
    - hydrochloric acid.

The great importance of these chemicals is obvious: they

are necessary for many other manufactures, and they are of great use in everyday life.

There are many districts in Britain where the manufacture of these chemicals is carried on, but it is clear that there will be some advantage in having the works near the source of

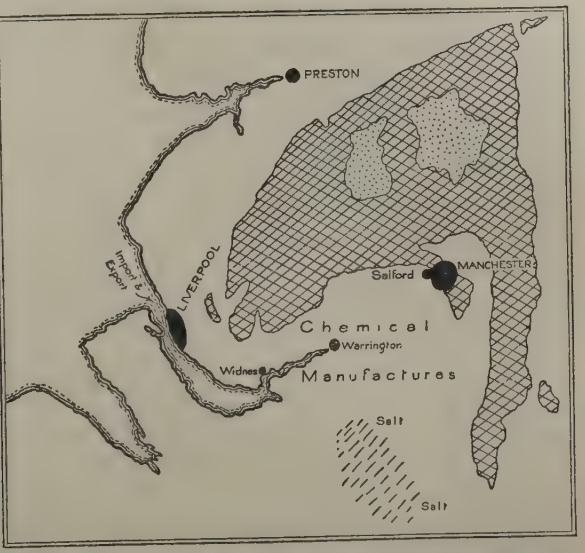


FIG. 56.—SHOWING HOW THE GREAT CHEMICAL MANUFACTURES OF THE MERSEY ARE PLACED BETWEEN THE SALT REGION AND THE LANCASHIRE COAL-FIELD.

The coal-field is shown by crossed lines.

the chief raw material—common salt. The most important chemical region of this kind is in **South Lancashire** and **North Cheshire,** and its development there illustrates three essential conditions of a great manufacture—raw material, fuel, and means of transport. The raw material is the salt of Cheshire; the coal of South Lancashire is the fuel; and the means of transport include the Mersey, the Ship Canal, the other small canals, and the network of railways between Manchester and Liverpool.

The manufacture of some of these chemicals is carried on in East Lancashire, in the West Riding of Yorkshire, on the South Staffordshire coal-field, and in the Glasgow province.

(*c*) **The Mineral Acids and the Common Alkalies.**—There is a good deal of interdependence between the four chief groups of chemicals. **Caustic soda, washing soda,** and **bicarbonate of soda,** mentioned in the last group, are among the alkalies. **Hydrochloric** acid, one of the common mineral acids, is obtained from common salt as a by-product in the old process for the manufacture of washing soda. It is quite a common thing, therefore, for the production of the common **acids, sulphuric** and **hydrochloric,** which are in such great demand, to be carried on in the same works as that of the alkalies. As an illustration, a great " chemical works " known to the writer produces the following series of commercial chemicals :—

Sulphuric acid.	Caustic soda.
Hydrochloric acid.	Bleaching powder.
Nitric acid.	Chlorazone.
Washing soda.	Sulphur.
Bicarbonate of soda.	

These work together well, because the materials used in one are frequently by-products of another.

A recent writer on " Industrial Chemistry " describes **sulphuric acid** (" oil of vitriol ") as the king of all chemical products, and says that the amount consumed by a country may be taken as a fair measure of its civilisation. The United Kingdom produces over four million tons per annum.

The great chemical region of the Mersey is the foremost producer of these " heavy chemicals " (acids, alkalies, etc.) in the British Isles. There are also great works in East Lancashire, at Leeds, in the Newcastle district, in the Glasgow district, in the Birmingham district, and in East London.

(*d*) **The Derived Chemical Manufactures—Soap, Paper, Leather, and Glass.**—These come more closely into touch with

the general public, being articles of everyday use, but their manufacture depends directly on some of the chemicals mentioned above.

Soap.—The raw materials for this manufacture are fats, caustic soda (or potash), and common salt. Hence the distribution of soap factories is influenced by the supply of these raw materials. A portion of the fats used is produced at home; but the greater part of it comes from abroad in the form of tallow, coco-nut oil, cotton-seed oil, palm oil, and other oils. Hence nearness to ports is an important consideration. Some of the oils and fats are obtained from the oil-seeds or oil-nuts at the port of entry; and it will be readily understood why so many soap-works are located on or near the Mersey and the Ship Canal, near the mouth of the Dee, on the Thames, at Hull, and at Glasgow. There are many inland works, however: among others, in East Lancashire, at Leeds, Wakefield, and Halifax, at Nottingham, and in the Birmingham district. It should be remembered that a plentiful water-supply is another factor in determining the position of great soap-works.

Paper.—For this manufacture the raw materials are wood-pulp, the Mediterranean grasses (esparto grass, alfa grass, and delta grass), cotton waste, linen rags, waste paper, and some of the alkalies, together with barytes, gypsum, resin, starch, etc.

One of the most important considerations is an excellent supply of suitable water, and this, more than any other factor, influences the position of paper-works. If good water can be obtained in plenty in a district not far from the ports where wood-pulp and the grasses are imported, and also where the necessary chemicals and fuel are readily obtainable, then the conditions are ideal, and paper-works are likely to be found there. The Rossendale Fells in Lancashire furnish plentiful supplies of soft water, the chemical works are near at hand, the Lancashire coal-field supplies the fuel, and the great markets of Lancashire demand immense quantities of paper.

It is not surprising that on the margins of these Fells, and in the valleys carved out of them, numerous paper-works are found. Especially is this true of the hill-slopes and valleys looking towards **Manchester,** the great market for the output of the paper. There are also many paper-works on the western slopes of the Southern Pennine moorlands, where the heavy rainfall ensures a good supply of water.

Important paper-works are also found in the Hertfordshire valleys and in Kent near the great London market, in the West Riding of Yorkshire, and near Glasgow and Edinburgh.

Leather.—There are two processes for tanning or making hides and skins into leather, known as the vegetable and mineral respectively ; for both of them it is an advantage to be near a good supply of hides and skins. Lime, sodium sulphide, sulphuric acid, hydrochloric acid, and ammonia are important chemicals used in the various processes. After some preparatory processes the hides or skins are converted into leather by allowing the vegetable or mineral tanning materials to act upon them for a sufficient length of time. Among the vegetable-tanning materials are oak bark, oak extract, larch bark, hemlock bark and extract (obtained from the United States chiefly), chestnut extract (from the south of France, north-west of Spain, and the Carpathians), quebracho (from South America), gambier (from the Malay States and East Indian Islands), and sumach (from the Mediterranean). The British Isles produce only a small proportion of the vegetable-tanning materials used ; hence there is a tendency for tanneries to be located near the ports. Among the mineral tanning materials the chief are alum, chromium compounds, and hyposulphite of soda, so that tanneries are frequently situated near the centres of chemical industry ; but the cost of carriage on these chemical materials is not very heavy, hence this factor does not count so much as some others.

Nearness to supplies of hides and skins means, of course, nearness to the great centres of population, and to the ports,

for the British supplies are not nearly enough to satisfy the demand. All these considerations are more or less secondary compared with the need of plentiful supplies of good water, for this is a first necessity in successful tanneries.

Three districts have developed as the chief centres of leather manufacture; these are Bermondsey (in South-east London), Leeds, and the Mersey. **Bermondsey** and **Leeds** have colleges for the training of men for the leather industry, and for the investigation of problems connected with that industry. There are numerous works in various parts of the country, dealing with local supplies of skins and hides, or producing some leather speciality. Among others, important works are situated at Whitehaven, Colne, Bolton, Liverpool, Wrexham, and Nottingham. The leather produced is worked up into various finished articles on the big scale in London, Leeds, Manchester, Stafford, Walsall, Northampton, Leicester; and on the smaller scale in almost every town in the United Kingdom.

Glass.—The raw materials for this are flint, sand, alkalies, lime, and smaller amounts of other chemicals. In addition to these, there must be cheap fuel at hand, and nearness to great markets is important.

The chief districts in Britain are St Helens and other parts of South Lancashire, and Castleford, Knottingley, and Rotherham on the West Riding coal-field; the South Staffordshire coal-field, the Newcastle district, and London.

CHAPTER XIV

ENGINEERING AND ALLIED TRADES

Some reference was made to the iron industry of the British Isles in Chapter XII. in the discussion on metallic ores. This subject is now carried further. The three raw materials for iron-smelting are iron ore, coke or coal, and limestone. Very rarely are these found together. In some cases the coke is carried to the ore, and in others the ore is carried to the fuel; limestone, or lime or dolomite, as the case may be, has frequently to be brought from an entirely different district. We will study some examples.

(*a*) The **Furness** district of Lancashire has its hematite ore *in* the limestone; here are two of the raw materials on the spot. The coke is brought across the Pennines from **Darlington** district, or round the Bowland Fells from the **Burnley** coal-field, or from South Lancashire or South Yorkshire. Many of the furnaces are actually some distance from the Carboniferous Limestone rim of the Lake District,[1] and have been built near the coast so as to make use of imported ore in addition to the local ore.

(*b*) **Middlesbrough** lies between the rich ores of the Cleveland Hills and the most important coke-producing district, viz. **Durham.** The limestone is brought from many parts of the Northern Pennines.

(*c*) The **South Staffordshire** coal-field uses local ore and ore imported from Northamptonshire and Oxfordshire; it imports coke from as far afield as South Yorkshire, as

[1] See p. 157.

the local coke is not considered to be suitable for some purposes.

Engineering.—Cast iron, wrought iron and steel, with copper, zinc, lead, antimony, nickel, and aluminium, form the basis of the great engineering trades, using the term in its very widest sense. Anything that does useful service by

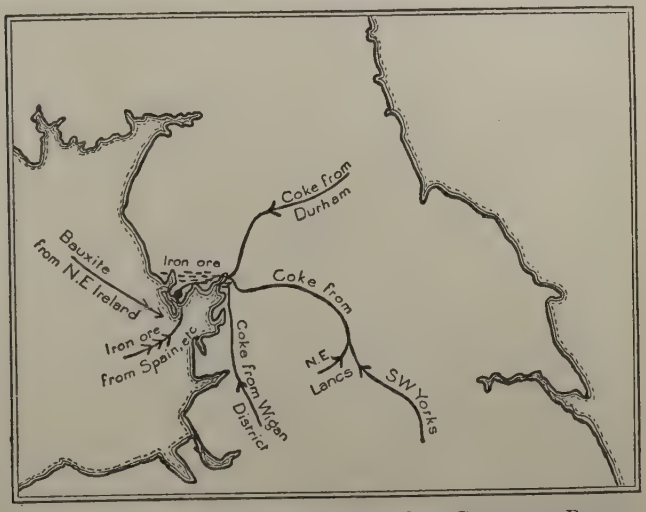


FIG. 57.—SOURCES OF SUPPLY OF IRON ORE, COKE, AND BAUXITE FOR FLUXING, USED IN THE FURNESS IRON-SMELTING DISTRICT (INCLUDING BARROW, DALTON, ULVERSTON, MILLOM, AND CARNFORTH).

using wind, or water, or steam, or electricity, or chemical energy, or gravitation, is here included as a machine, and "engines" are, of course, machines for special work. These engineering and machine trades are very highly developed in the United Kingdom, and are among the most important factors in giving to Britain the high position she occupies among the industrial nations. It is necessary to make certain divisions for convenience of study, but there is a great deal of interdependence and overlapping.

Agricultural Machinery.—As agriculture deals with the first of all necessaries, food, and as it employs more people than any other industry, even in the United Kingdom, machinery adapted to it is given first place. Many of the great iron-working centres make agricultural machinery; and in a sense the seed-crushing machinery at the great ports may be regarded as partly belonging to this class, because the seed-cake produced after the oil has been pressed out is an important feeding-stuff. There are great works in many agricultural market towns—towns which have been agricultural markets from time immemorial. The machinery works there have grown up to meet the changing needs of modern agriculture, which depends more and more upon labour-saving machinery. Some of these towns are London, Rochester, Chelmsford, Bedford, Ipswich, Norwich, Northampton, Peterborough, Grantham, Lincoln, Selby, Ripon, Darlington, Carlisle, Penrith, Preston, Chester, Oswestry, Hereford, Worcester, Banbury, and Wellington. It will be seen that most of these towns are in the middle of great agricultural districts.

Machinery for Mining and Quarrying.—Most of this is made in the great industrial iron-working centres. Many of these are mining districts as well, and the manufacture of mining machinery is an important branch of their own industries. Many towns located on or near the coal-fields or iron-fields specialise in this work. Beginning in the north, Glasgow, Paisley, Kilmarnock, Motherwell, and Kirkcaldy all make machinery suitable for **coal-mining,** for getting, transporting, and crushing the **black-band ironstone,** and for use in the ironworks. In the Scottish Lowlands another place which makes mining machinery is the famous **Carron works,** a works which proudly announces in its advertisements, "Founded in 1759."

In the north-eastern industrial region machinery for coal and iron-mining is made on the Tyne, and at Durham, Dar-

lington and Middlesbrough. The lead-mines and stone-quarries of the neighbouring Pennines also look to Newcastle and the Tyne for machinery.

Still farther south, Leeds, Wakefield, Dewsbury, Rotherham, Sheffield, and Chesterfield produce different kinds of machinery for mines and quarries; and across the Pennines are Wigan, Liverpool, St Helens, Warrington, Manchester, and Dukinfield where machinery of this kind is made.

In the Midlands, at Stoke, Birmingham, Wolverhampton, and Tipton (Staffordshire); and in South Wales and across the Severn, at Cardiff, Blaenavon, Bridgend, Llanelly, and Bristol, such machinery is made. To these lists London may be added as the place of actual manufacture of certain types of mining and quarrying machinery, and as the depot or headquarters for a good deal more.

Textile Machinery.—This is a most important branch of engineering, because, if Britain's supremacy in the making of textiles is to be maintained, the machinery used must be of a high standard. Improvements are continually taking place, and that community which is quickest to appreciate and to use new ideas will remain in the front rank, while failure to keep abreast in machinery means falling into the rear of great industrial nations. Textile machinery is exceedingly varied in character, elaborate and expensive in construction, wonderfully adapted to the purposes it has to serve, and few can fully appreciate it except those engaged in the industry.

Every large town connected with the different textile industries makes some kind of speciality, some engine or machine or part of a machine; but there are certain towns that stand out, where great works are established to manufacture machinery adapted to some preparatory, spinning, weaving, or finishing process. Naturally, these are nearly all located in or near the great textile centres, for there men understand the needs of the textile manufacturers better, and the cost of carriage of the finished machinery is less. Many

firms which were originally established to deal with machinery for the textile industries at home now make a great deal for export. Some of the greater works employ thousands of workers, including skilled designers and draughtsmen, and the names are almost household words in the great textile districts. For example, one firm at Oldham is said to employ over 12,000 workers. The towns more especially famous for textile machinery of one kind or another are: Manchester, Oldham, Ashton, Stalybridge, Stockport, Bolton, Bury, Rochdale, Blackburn, Accrington, Burnley, Colne, Keighley, Huddersfield, Leeds, Bradford, Glasgow, and Nottingham.

Electrical Engineering.—This young industry has rapidly grown to be a very important one. In almost all parts of the country are to be found works which either make some electrical speciality or which purchase the parts and "fittings," and either build machines or undertake installations. The greater works have, however, developed in a few important industrial centres, either owing to the nearness of metals and the supply of skilled metal-workers, or owing to the demand for dynamos and fittings in a great industrial community.

Probably the three greatest centres are **Manchester, Birmingham,** and **London,** with well-known works at Stafford, Rugby, Coventry, and Newcastle. Glasgow, Leeds, Sheffield, Huddersfield, Nottingham, Preston, Warrington, Derby, and Worcester are other towns where some branch of electrical industry is established on a large scale.

Railway Engines and Railway Plant.—All the great railway companies have engineering works where they build their own engines and turn out most of their own fittings. The Great Western Railway has works at **Swindon,** the London, Midland, and Scottish at **Crewe, Derby,** and **Horwich,** the London and North-Eastern at **Doncaster, Darlington,** and **Stratford,** and the Southern Railway at **Ashford** (Kent) and **Eastleigh** (Hampshire). Much railway machinery and plant, in many

cases including locomotive engines, is made in London, in Birmingham and district, in Manchester, in Leeds, in Newcastle and district, and in Glasgow and district. As examples of railway wagon and coach works, Wolverton, Nottingham, Peterborough, Wakefield, Heywood, Earlestown, Chorley, Wigan, and Lancaster may be quoted. **Birmingham** makes all sorts of odds and ends for railways, just as it does for tramways, motor cars, bicycles, and ships.

Tramcars and Tramways.—These are made in London, Birmingham, Loughborough, Leeds, Manchester, and Preston.

Motor Cars, Bicycles, Motor Bicycles, Motor Buses, Motor Wagons, and Steam Wagons.—The making of these has now grown to be a very great industry which is very widely spread over different parts of the country. There are, however, certain towns and districts which have taken up the new production with great keenness, and there big factories are now found. Though possibly not the most important, **London** and suburbs and district may well be mentioned first, for there are noted works in many parts of greater London and in the small towns not far away. Dartford, Maidstone, Guildford, Woking, Harrow, Watford, and Romford may be included in the London province for this purpose. The towns which probably take first rank in this industry are **Birmingham** and **Coventry,** where many famous makes of all these modern forms of travel and transport are turned out. To the west and north of the great Midland city, Redditch, Willenhall and Wolverhampton are also famous for this work.

Other Midland towns which have made a name for the production of some of these vehicles are Derby, Nottingham, and Northampton ; while farther east are Lincoln, Peterborough, and Ipswich.

In the West Riding, Sheffield, Leeds, Bradford, and Huddersfield produce motor wagons, while across the Pennines are numerous works for motor cars and motor wagons in Manchester and district. One must not overlook, too, the

great works at Sandbach in Cheshire and at Leyland in Lancashire. Preston also takes a share in this great modern business.

Southampton, Bristol, Newcastle, and Glasgow may be added to the places where either bicycles or motor cars or motor wagons are manufactured.

Aeroplanes and Aeroplane Parts.—This manufacture is obviously still in its infancy, but already big works have been erected, and certain localities have begun to specialise in this new industry. **London** and Greater London, including Woolwich, Crayford, Woking, Kingston-on-Thames, Hendon, and Cricklewood, must be given first place. Other places are Bristol, Yeovil, Birmingham, Wolverhampton, Leeds, Manchester, Sheffield, and Norwich.

Ships, Ship's Engines, Ship's Fittings.—Shipbuilding in the full sense is one of the most important industries in the United Kingdom. Not only are the British the greatest shipbuilders in the world, but importing and exporting are the very life blood of the nation—bringing in foods and raw materials, sending out manufactured goods of many kinds: if these lessen to any great extent, Britain becomes a second-rate nation at once. Hence the very great importance of shipbuilding, in which Britain excels both in quality and in quantity. Taking the returns for a year, 1st October 1927 to 30th September 1928, as typical, and omitting warships and vessels of less than 100 tons, the United Kingdom launched 1,163,419 gross tonnage, whilst the rest of the world launched 497,917 gross tonnage of merchant shipping, Britain's share being 70 per cent of the whole. This shows Britain's commanding position, but see note at end of the chapter.

The chief **shipbuilding districts** in the British Isles, again omitting warships, are: the Clyde, Belfast, the Mersey, the Humber, the Tees, the Wear, the Tyne. The last three, conveniently known as the North-Eastern Shipbuilding District, launch nearly half the tonnage of the United

Kingdom. Measured by "horse-power," the Clyde and the North-Eastern District produce about equal shares, together accounting for about 80 per cent. of the whole of the United Kingdom.

Marine engineering is obviously a most important adjunct to shipbuilding, and the two great districts of the Clyde and the North-East excel in that branch of engineering. Bootle, Birkenhead, and London are also engaged in it.

Birmingham obviously cannot build ships, but it is a great provider of all sorts of internal fittings—minor machinery, door fittings, lamps, navigators' instruments, anchors, wire ropes, chains, cooking utensils, and berth fittings.

There are other kinds of machinery, such as that for boots and shoes, for clothing, for printing, and many others; but this chapter gives an idea of the distribution of the more important kinds, and these must serve for the whole.

Note on Shipbuilding

For some years the shipbuilding industry of this country has been severely depressed. During the year 1932–33, only 111 vessels of 449,751 tons gross were built in Great Britain and Ireland. Nevertheless the United Kingdom still owns nearly 30 per cent. of the merchant shipping of the world.

CHAPTER XV

THE TEXTILE INDUSTRIES

TEXTILES are woven goods [1] made up of what, in the industry, are called warp and weft. It would not be possible to explain the complexities of weaving here, nor would it be to our purpose. The student of geography is concerned with the factors which have led to the distribution of the various branches of these industries, and with their relation to and influence on each other. Textiles do not employ so many workers as do some other industries, but the manufactured goods produced are those by which Britain is especially known abroad. The British are easily first among the makers of textiles. This is partly because nearly all the great inventions in the textile trades have been British, and also because much of the early growth of these great modern industries took place in the British Isles. Other factors are the suitability of the British climate, and the central position of the British Isles in the world of land masses.

The threads of warp and weft are of various kinds—wool, cotton, linen, jute, hemp, ramie, silk, and "artificial silk." Woven goods are frequently made of one kind of fibre alone, but the manufacture of cloth of mixed fibres is very considerable. The oldest great British textile industry may be taken first—that is, the **wool** industry. According to the length and quality of the fibres used, it is usual to speak of two branches —**worsted** and **woollen.** The former deals with the longer fibres, the latter with the shorter fibres. The worsted in-

[1] Latin: *texo, tectum,* to weave.

dustry is mainly concerned with fine dress goods and high-class suitings ; the woollen industry deals with the manufacture of flannels, blankets, tweeds, and serges. The source of raw wool is, of course, the sheep, but in the great Bradford province there is used a good deal of mohair, alpaca, and vicuna fleeces.

The wool is first of all cleaned or scoured, then it is combed or carded, and afterwards spun into threads either for warp or weft. The weaving in the loom follows. A considerable amount of the raw wool is produced in the British Isles, but much more is derived from abroad, the chief sources being New Zealand, Australia, South Africa, Argentina, the United States, and Canada. Before the war Russia also sent us a large amount of wool. Taking a year immediately before the great unsettlement caused by the war, the total wool imported was 880,000,000 lbs., and the amount produced in the United Kingdom was 120,000,000 lbs., or less than one-eighth of the total used. About one-third of the imported and domestic wool was exported as wool, and about two-thirds was retained for home manufacture. The great wool market is **London,** but arrangements have recently been made for wool sales in Manchester and Hull, ports which are much nearer to the greatest wool-using district—the West Riding of Yorkshire.

In Chapter XI., under the heading " Sheep," some mention was made of the localities where manufactures of wool are carried on ; these will now receive further mention. In the Middle Ages and in early modern times, the most famous region for wool manufacture was East Anglia, with Norwich as the great centre. The name worsted, applied, as we have seen, to spun wool of long fibre, came from a village near Norwich, and it has now taken a permanent place in our language. There were also manufactures of wool in the West Riding dales, at Rochdale, in the " West Country," and in many other less famous districts scattered over the country. With the advent of the Industrial Revolution—the age of cheap iron, coal-power, new inventions in spinning and weaving,

and improved transport—the industry began to leave East Anglia and to settle on or near the coal-fields.

The West Riding of Yorkshire had long been famous for its woollens and worsteds ; the sheep of the Pennines and the abundant water supply had been the factors on which the industry had grown up. Defoe spoke in terms of admiration of the greatness of the industry in his day. With the coming of the era of big factories the industry gradually shifted from the remote Pennine dales and became concentrated mainly in the valleys of the Aire and Calder and their tributaries. **Leeds, Bradford, Halifax,** and **Huddersfield** are the great towns and cities engaged in the manufacture and in marketing. Other towns of importance are Dewsbury, Batley, Morley, Pudsey, Keighley, and Bingley, with a host of smaller towns and large villages. Some of the mills in the neighbourhood of **Bradford** are among the finest in the world. Bradford is the great market for the manufactured goods, and it deals in fine cottons as well as worsteds ; and cotton manufacturers from Nelson and Colne in East Lancashire attend Bradford Exchange.

There is a well-known and considerable wool industry near the south-western end of the Cotswolds, where the famous West of England "**broad cloth**" is made. Bradford-on-Avon, Stroud, Frome, and Devizes are towns in this region. On the lower slopes of the Cotswolds, not far away, the famous **Witney blankets** are made. Outliers of this industry are found in West Somersetshire and Devonshire. It will be noticed again that the Cotswolds and the Chalk Downs are both noted for sheep-rearing.

The Welsh sheep of Merioneth and Montgomeryshire were responsible for the old-established industry of the **Welshpool** and **Newtown** districts. This industry, like those mentioned above, dates from the days of hand-looms and home-spinning, and later of small water-mills. When it was once established it persisted when the changed conditions came, and coal was

brought from the Severn coal-fields some distance away. There are signs now, however, that the attraction of the coal-fields is proving too great, and the industry is said to be declining.

There is a considerable woollen manufacture in **East Lancashire,** though, of course, it is completely overshadowed by the vast cotton industry. Rochdale has made flannels and blankets for a long time, and the industry still flourishes. Bury, not far away, and even Oldham, have their woollen mills. The slipper industry of Rossendale, to be mentioned later, is, to some extent, founded on the felt industry of Rossendale, which is an associate of the flannels and blankets of Rochdale and Bury.

The **tweed** cloth industry of the Southern Uplands of Scotland is clearly associated with the great number of sheep reared in those uplands, and with the abundant water supply of the Tweed and its tributaries. Hawick and Galashiels are the chief centres.

In addition to the worsted and woollens made in these well-defined industrial regions, there is in the British Isles a good deal of scattered, local manufacture. Perhaps the most interesting aspect of this minor industry is that of the "**homespuns**" of the Highlands and Western Islands of Scotland.

The Cotton Industry.—This is not only the greatest of British textile industries, but it is the greatest in the world. Unlike the wool industry, it is almost entirely modern in its development, and is largely confined to one particular region, namely, the eastern part of South Lancashire, with extensions into the adjoining parts of Yorkshire, Derbyshire, and Cheshire. This is the busy region of which **Manchester** is the marketing centre and the railway focus.

Most of the great discoveries connected with the cotton manufacture were made in this industrial province, the chief of these being :—Kay's "flying shuttle," Kay the younger's

"drop box," Hargreave's "spinning jenny," Arkwright's "water frame," Crompton's "mule," Peel's development

FIG. 58.—TEXTILE INDUSTRIES OF THE BRITISH ISLES.
1. Cotton. 2. Wool. 3. Silk. 4. Linen and Jute.

of calico printing, and Mercer's discovery of the process which bears his name: these were East Lancashire inventions.[1]

[1] See "South Lancashire" in the *Cambridge County Geographies*, Cambridge University Press.

There is one feature in which the cotton industry is quite unlike the wool industry—not a scrap of **raw cotton** is produced in Britain ; it comes entirely from abroad, at present most largely from the United States of America. This fact ought never to be overlooked in discussions about the cotton trade ; nor should the equally important fact that 80 per cent. of the cotton goods produced are sent abroad. The great Lancashire industry is thus remarkably dependent upon foreign trade and shipping.

There are two principal processes in the manufacture of cotton cloth—**spinning** and **weaving.** The **spinner** takes the raw cotton just as it comes from the United States, Egypt, India, or Uganda, and after some preliminary operations he spins it into yarn, which will afterwards be either warp or weft as the case may be : this is the first great operation. Spinning is mainly carried on in the district comparatively near to **Manchester.** There is a great crescentic curve of busy towns and villages which includes Stockport, Ashton, Oldham, Rochdale, Heywood, Bury, Bolton, and Leigh. It will be seen that these form a curve round Manchester. This is " the great spinning region," and it contains about 32,000,000 spindles, or about 80 per cent. of the whole in the Manchester province.

The other principal operation is **weaving,** which is also largely localised in a particular region. The towns and villages north of the Rossendale Fells are as important in connection with weaving as the towns mentioned above are in connection with spinning. The **weaving zone** includes Preston, Chorley, Blackburn, Darwen, Accrington, Burnley, Nelson, and Colne, and a number of smaller towns and large villages. Here are found about 75 per cent. of the looms of the great Manchester cotton province, whilst in the same zone there are only 6,000,000 spindles, or less than one-fifth of the number in the southern spinning zone. **Blackburn** claims to have more looms than any other town in the world, and **Burnley** claims to turn

out more yards of cloth than any other town in the world. Preston, Chorley, Nelson, and Colne produce very varied and high-class cotton goods.

Between the great zones of weaving and spinning are the towns of the Rossendale Fells—Haslingden, Rawtenstall, and Bacup. These have both spinning and weaving and are also largely concerned with the cotton-waste trade. They correspond somewhat to Dewsbury and Batley in the West Riding, which use large quantities of wool waste and shoddy.

Running through the cotton trade is the very important branch of **bleaching, dyeing, printing,** and **finishing.** These processes are obviously dependent on the chemical industries and also on plentiful supplies of good water. The Rossendale Fells are largely made of porous sandstones and grits, and there is a heavy rainfall distributed fairly well throughout the year. Here are hundreds of springs and small moorland streams of remarkably soft water, and in consequence works carrying on the operations mentioned are clustered round the edges and among those Fells. (See fig. 10, p. 29.)

The great **market** and centre is **Manchester,** where there are immense warehouses for the reception, storage, and distribution of the finished goods. The merchants and manufacturers meet in Manchester, chiefly on Tuesdays and Fridays, when at least 10,000 men congregate in the Exchange and its neighbourhood for the transaction of business.

Cotton goods are manufactured outside the immediate Manchester province in **Nottinghamshire** and in the **Glasgow** district. **Paisley** is an important centre for the manufacture of cotton goods, and there also is the greatest manufacture of sewing-cotton in the world.

The Silk Industry.—This is one of the oldest of British industries, but it is now only a comparatively small one. It includes many kinds of specialities, among which are: dress silks, furniture silks, umbrella silks, mourning crepe, silk ties, mufflers and handkerchiefs, and silk hosiery. From the

variety of goods produced it is not surprising that the industry is scattered over a wide area, the most important places being Bradford, Halifax, and Brighouse in the West Riding of Yorkshire, Macclesfield, Congleton, and Leek in Cheshire, Manchester, and Stockport district, Glasgow, Derby, Coventry, Sudbury, Norwich, London, and Taunton. All the raw silk is imported, about half of it from China, the rest mostly from Japan, Italy, and France.

The Linen Industry.—The spinning of flax and the weaving of linen goods is an old British industry. It is now located chiefly in the north of Ireland and in the east and central Lowlands of Scotland. Belfast, Dundee, and Dunfermline are the chief markets. **Belfast** is the centre of the fine linen industry; **Dunfermline** is the chief centre for damasks; **Dundee** and district makes linen goods chiefly from Continental flax. There are linen industries at Leeds, Barnsley, Manchester district, and Kidderminster.

The Jute Industry.—This is a much younger industry, which is now located chiefly in **Dundee** and the neighbourhood. Jute is largely grown in India, and British supplies come mainly from there. From the fibres are woven sacks, sugar bags, cordage, matting, and similar textiles.

Ramie.—This is a fibre obtained from China, Siam, and India, which is now made into cordage, fishing-nets, and the basis of incandescent gas mantles. Its manufacture is confined to a few localities in Britain, and is still in the early stages of experiment.

The use of **mercerised cotton** and **artificial silk** is now very considerable, but its consideration belongs rather to a technical account than to that of a geographer. It is perhaps enough to say that many scattered works in the district round Bradford, in the neighbourhood of Manchester, and in north-east Lancashire make goods from these fibres which to some extent replace textiles made from real silk.

CHAPTER XVI

THE DISTRIBUTION OF CLOTHING MANUFACTURE

After food the first necessity of man is clothing, and in modern communities the manufacture of clothing finds occupation for large numbers of people and fills an important place in industrial life. There were over one million people directly engaged in the manufacture of clothing in the United Kingdom before the Great War.

As the British Isles are noted for their textile industries, and produce and export such large quantities of textile goods, it follows that large quantities of clothing are made for home use and for export. Naturally, many of these articles of clothing are produced in the great textile districts, but large clothing factories are found in many of the bigger market towns and distributing centres where there are no textile factories or mills.

In this chapter the word clothing will be used in a very wide sense, and will include underclothing, hats and caps, collars and ties, boots and shoes, slippers, gaiters, leggings, and waterproof clothing.

Men's clothing, including uniforms of various kinds, is made in almost every town of considerable size, and there are also large clothing factories in many country districts. **Manchester, Leeds,** and **Bradford** produce what is called " ready-made " clothing on the big scale. In the two first named a considerable Jewish population is engaged in the industry.

London also has an immense clothing manufacture, chiefly located in the City itself, and in Shoreditch, Bethnal Green, and Poplar, where the work is largely in the hands of Jews, especially "Polish Jews." Many of the London factories are well equipped, and turn out not only the cheaper kinds of ready-made clothing, but also high-class work, including uniforms for men and women engaged in many departments of Government, county, or municipal service. Much of the clothing for the army, the navy, and the air force is made in these London factories. Leather clothing for the air force, the navy, and motoring has of recent years become an important feature of the London clothing trade.

As an example of clothing manufacture in country districts, the small town of **Hebden Bridge**, in the West Riding of Yorkshire, may well be quoted as an illustration. Here are made "**fustians**" and "**moleskins**" for mill-engineers, mechanics, miners, and other artisans. The fustian is woven in Hebden Bridge and the neighbourhood, and the natural consequence is that the clothing is now made in the town and district. Many similar examples could be found, but this will serve as an interesting type.

Underclothing is made in London (West End, City, and East End), Manchester, Leeds, Bradford, Nottingham, Leicester, and Glasgow, and in addition there are scattered factories in many smaller towns and in many rural districts. It will be noticed that, with the exception of London, the larger towns quoted are associated with some form of textile industry. London maintains its share of the manufacture because it is such a great market, with facilities for distribution to all parts of the British Isles, to the Dominions, and to the world in general.

Hosiery depends upon wool, cotton, and silk, and its manufacture is carried on to some extent in Manchester and Leeds; but Leicester, Nottingham, and London are more famous for hosiery manufacture on the large scale.

The manufacture of **hats,** in silk, felt, and velour, is largely concentrated in a district to the south and south-east of Manchester, including Denton, Hyde, and Stockport. A share of this industry is also claimed by Leeds, Atherstone (Warwickshire), and London.

Men's and boys' **caps** are made in the same district as the hats, but probably more largely in Manchester, Leeds, and London, where this branch of industry is associated to some extent with the general clothing trade. The materials in demand for the manufacture of caps and ordinary men's clothing are much of the same kind.

An interesting branch of modern clothing manufacture is that of various kinds of **rain-proof clothing.** The older kind is that which was originally made by Mackintosh, and which still bears his name. This waterproofing process is mainly carried on in the Glasgow district and in Greater Manchester. It is generally understood that **Glasgow** specialises in the more expensive kinds of waterproofs, while **Manchester** devotes itself to the cheaper grades. There are, nowadays, other processes by which very light waterproof clothing is made on the one hand, or heavy " oilskins " on the other. Both kinds are produced in London, Leeds, Manchester, and Glasgow. Glasgow is a well-known locality for well-made oilskins for the navy, the merchant service, and the sportsman. Other centres are Norwich and Yarmouth.

Boots and shoes were referred to in the chapter dealing with the manufacture of leather; they may be mentioned again here. There is a good deal of local specialisation in this industry. The **Midlands** of England generally is the great home of boot and shoe manufacture. Women's and children's boots and shoes are made at Leicester, Lutterworth, Rushden, Hinckley, Kettering, and Nuneaton; the heavier men's boots and shoes are made at Northampton and district and at Stafford. There are boot and shoe factories in London and in Leeds, obviously located near the leather-producing

regions. There are also many well-known factories scattered over different parts of the country.

A somewhat related industry is the famous **slipper** manufacture of **Rossendale** in East Lancashire. The rapid development of this industry may well be quoted as one of the romances of modern British zeal and determination. Founded about half a century ago in quite a small way, the industry has grown to such an extent that some thousands of workers now find employment in Rawtenstall, Waterfoot, and Bacup ; and Rossendale (the valley where these towns are situated) claims to be the premier maker of slippers in the world. Many of the slipper factories are derelict cotton-mills which have been modernised. It is probable that the marvellous growth of this industry has been partly due to the nearness to Bury and Rochdale—towns where a good deal of felt has long been produced.

Gaiters are made in London, in the Midlands, at Leeds and Manchester ; the cloth, leather, buttons, and other materials being much the same as are in demand in the different branches of the ordinary clothing industry.

Leggings are made in the same districts as boots and shoes, many works being situated in those parts of the Midlands where heavy boots are made. London, Leeds, Manchester, and Newcastle also have their makers of leggings.

Linen collars are a speciality of the north-east of Ireland, being made at Belfast, Coleraine, and Ballymena. Cotton, woollen, and mixed fabric collars are made in London, Manchester, Leeds, and Glasgow.

Ties have already been mentioned in connection with the silk industry. The chief localities are Belfast, Dublin, Leeds, Manchester, Derby, Belper, Coventry, Glasgow, and London.

CHAPTER XVII

TRAFFIC AND TRANSPORT

The progress and welfare of a people depend very largely upon the excellence and completeness of its means of travel and transport. This is an unusually important factor in the British Isles, because so much food and raw materials have to be imported and distributed, and because so many important industries are located in certain limited districts.

In discussing transport and means of communication we shall take into account rivers, canals, roads, railways, and the sea.

Rivers.—The British Isles can have no really long rivers, and river travel and transport can never be as important as in Germany, for example. There can be nothing quite like the great inland port of Mannheim, hundreds of miles from the sea, with its service of well-equipped steamboats carrying goods and passengers up and down the Rhine. Britain can have no St Louis or Montreal, no Allahabad or Hankau—great traffic centres at the junction of mighty rivers. Yet British river traffic is by no means to be despised. There is no considerable stretch of coast line in Britain without an estuary which is navigable for barge traffic ; and there is no inland part of the British Isles that is very far removed from a navigable river mouth or an important estuary. The tidal wave penetrates the estuaries, and twice a day carries the water from the shallow sea far inland, thus making it possible to dock vessels, whereas in a tideless sea like the Baltic or the Mediterranean this would be quite impossible.

Canals.—The first important British canal was that made for the Duke of Bridgewater from **Worsley** to **Manchester,** planned and carried out by that wonderful genius Brindley. He had to carry his waterway across the Irwell valley, and

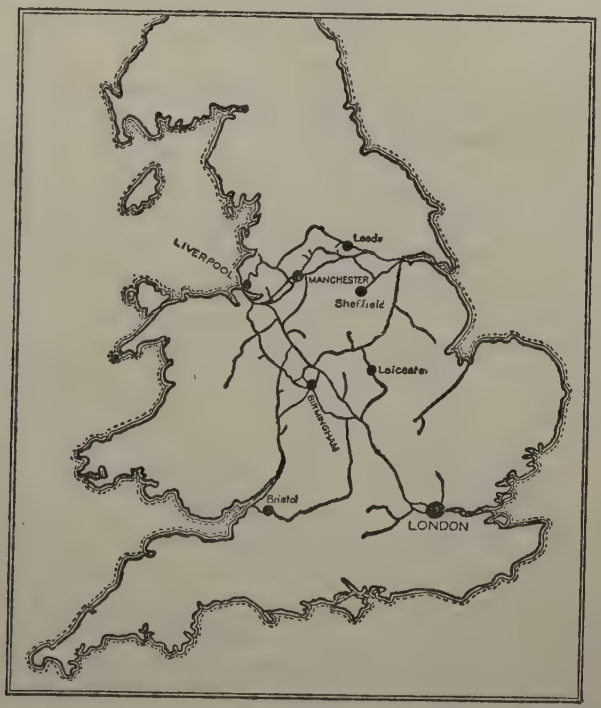


FIG. 59.—CANALS AND "NAVIGATIONS" OF MIDDLE ENGLAND.

this he must do either by descending and ascending in two series of locks, or he must raise it far above the level of the river. He chose the latter plan and made the famous **Barton Aqueduct,** puddling his raised waterway with clay to make it "water-tight." He also carried his canal at the Worsley end *into* the low hills of the Coal Measures so as to be within easy

reach of the seams of coal. The result of these daring devices was that the price of coal in Manchester at once fell by about one half. This was in 1759–60. The Duke of Bridgewater then decided to extend his canal, and during the years 1760–1772 it was carried to **Runcorn,** and thus laid one of the foundations of the industrial prosperity of South Lancashire.

The success of this great undertaking paved the way for the great canal era which set in after 1770, and which came to a close with the advent of railways in 1830–1840. Canals were made in many directions—over 3,000 miles of them. The **Grand Trunk Canal** joined the Mersey to the Midlands; the **Mersey and Trent Canal** linked up the west and the east; and the **Grand Junction Canal**[1] from the Midlands to the Thames completed the system by which London, Hull, Liverpool, and Bristol—the four gateways of the English Midlands—are connected. The **Pennine Canals** have been mentioned in Chapter I.

There are two **ship canals** in England. The **Gloucester** or Berkeley Canal avoids some of the windings of the river Severn and connects Gloucester with the Severn estuary. The more famous **Manchester Ship Canal** connects Manchester-Salford with the river Mersey at Eastham. The construction of this was commenced in 1887, and it was opened for traffic in 1894. It is thirty-five miles long, and is wider, for example, than the Suez Canal. It has made a great difference to the trade of the Manchester province, and has helped to make of the great city a centre for engineering, chemicals, timber, and various food products. The growth of traffic on the canal in the first twenty years is seen from the following figures:—

1894. Total tonnage handled, 926,000 tons.
1933. „ „ „ 5,389,000 tons.

Scotland has a ship canal in the well-known **Caledonian**

[1] Now a part of the Grand Union Canal.

Canal, which joins the eastern and western seas through the famous trough of Glenmore. This uses three lakes, and the length of canal in addition is about twenty-three miles. This canal has not fulfilled expectations as a business route, and has become largely a tourist canal. There is a short canal across the Kintyre peninsula of Scotland, which is also for the most part a tourist canal, and is now little used. Scotland has an important barge canal connecting the Firths of Forth and Clyde, and now the need is being felt of a ship canal to connect the North Sea with the Clyde estuary.

Ireland has numerous canals, as the existence of the Great Central Plain, and the direction of the rivers to the four seas, lend themselves to their construction. The chief are the **Grand Canal** from Dublin to the middle Shannon, with several branches; the **Royal Canal** from Dublin to the upper Shannon; and the **Ulster Canal.** These canals are not so much used as they might be.

Roads.—The oldest known system of good roads in Britain is that of the Romans, and many of our modern roads are founded on those old roads. Probably the most famous Roman road, which is a modern road also, is the **Watling Street** from London, through St Albans, to Towcester, Daventry, and the north-west of England. The **Great North Road** corresponds with **Ermin Street** for part of its course. During the long Saxon period and all through the Middle Ages the roads were neglected, and there was nothing comparable to the fine Roman roads. With the coming of the great industrial epoch of the eighteenth and nineteenth centuries, the need for better means of communication was felt, and road improvement and construction were entered into with great enthusiasm. " Blind Jack of Knaresborough " planned some of the famous roads of the industrial regions of the West Riding of Yorkshire and East Lancashire. **Telford** and his pupils made many excellent roads, perhaps the most famous of which is the one through North Wales to Bangor. The

Menai Suspension Bridge was the work of Telford. **Macadam** showed how to make a good and a more lasting surface, and the process bears his name to this day. By about 1830 the country had become possessed of a fine series of roads, and many of the "new roads" of the small towns and country districts date from that time. With the rapid growth of motor traffic now going on, the roads are again becoming more used, and are recovering the importance they had in the days of the stage-coach from about 1790 to 1840.

Railways.[1]—The parent of modern Railways was the **Stockton and Darlington Railway,** commenced in 1820 and opened for traffic in 1825. A much more ambitious railway was the one connecting **Liverpool** with **Manchester.** The engineer was the famous George Stephenson. He had great obstacles to overcome, the most troublesome being the crossing of Chat Moss. When the railway was ready in 1829, a prize was offered for the most successful engine, and Stephenson's "Rocket" won the prize. From this time the success of railways was assured, and a great era of railway construction set in which lasted until about 1870.

We shall not follow every line of railway—not even every main or trunk line; but rather indicate some general principles and bring out some important facts connected with railway distribution. The railways were planned for the most part to connect important towns, and to link up industrial districts with ports. London grew to be the focus of the great lines, though many of them began their construction in some part of the provinces. The study may therefore begin with the relation of the main lines to London. It will be convenient to begin in the City of London and work round towards the west, and then return citywards again. The first great terminus in the north of the City is Liverpool Street, a station of the **London and North-Eastern** Railway. The two main-line services from this terminus serve Chelmsford, Harwich,

[1] See note at end of chapter.

Ipswich, Norwich, and Cromer, and Cambridge, Ely, and King's Lynn. About one and a half miles away to the north-west is King's Cross, the next great terminus, also a terminus for the **London and North-Eastern** Railway, and the lines from it serve Peterborough, Doncaster,

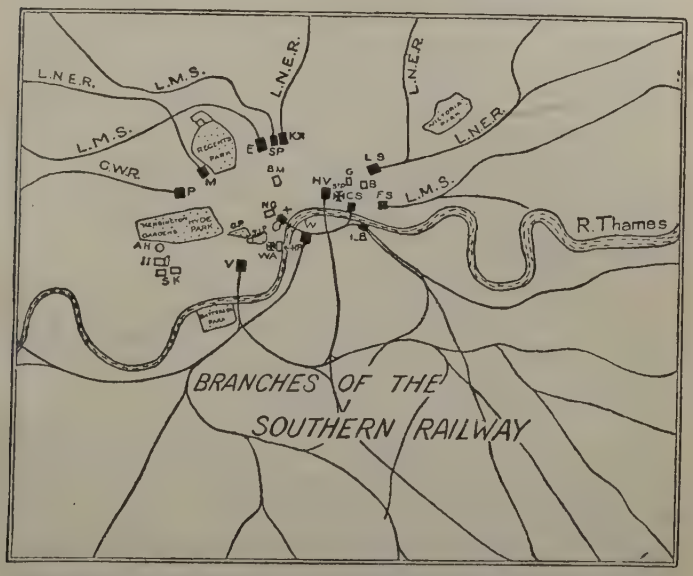


FIG. 60.—DIAGRAM MAP OF THE LONDON RAILWAY TERMINI.

Key to References.—L.S., Liverpool Street; S.P., St Pancras; M., Marylebone; V., Victoria; C.X, Charing Cross; C.S., Cannon Street; L.B., London Bridge; K.X, King's Cross; E., Euston; P., Paddington; W., Waterloo; H.V., Holborn Viaduct; F.S., Fenchurch Street.

Some important buildings: see key to fig. 68, p. 216.

York, and Newcastle. Close by King's Cross station is St Pancras, a terminus for the **London, Midland, and Scottish** Railway. This important station is the starting-point of trains for Bedford, Leicester, Derby, Manchester, Nottingham, Sheffield, Leeds, and Carlisle. A short distance to the west of St Pancras is Euston station, another terminus for the **London, Midland, and Scottish,** with a main line to Watford,

Rugby, Birmingham, Stafford, Crewe, Chester, Holyhead, Stockport, Manchester, Warrington, Wigan, Preston, and Carlisle. From Euston it is about a mile to Marylebone, the newest of the great termini of London. Here trains of the **London and North-Eastern** Railway start for Aylesbury, Rugby, Leicester, Nottingham, Lincoln, Sheffield, and Manchester. Paddington is about a mile farther, slightly to the south-west. This is the busy terminus of the **Great Western** Railway, whose numerous main lines serve Birkenhead, Chester, Shrewsbury, Wolverhampton, Birmingham, Leamington, Warwick, Hereford, Worcester, Gloucester, Banbury, Reading, Oxford, Bristol, Newport, Cardiff, Swansea, Caermarthen, Newbury, Taunton, Exeter, Plymouth, and Penzance.

Two and a half miles to the south-east from Paddington, across the Thames, is Waterloo, a terminus of the **Southern** Railway. Here trains start for Winchester, Portsmouth, Southampton, Bournemouth, Salisbury, Exeter, and Plymouth.

There were formerly three other great companies whose main lines started out from London southwards. These were the **London, Brighton, and South Coast** Railway, the **London, Chatham, and Dover** Railway, and the **South-Eastern** Railway. Each of these had two termini, one for the West End and one for the City. Two companies were amalgamated and are now part of the **Southern** Railway. The termini are not quite so easy to follow as are those of the great lines to the north and west. Victoria is a big terminus, on the north side of the river, about two miles south-east of Paddington and one mile south-west of Waterloo. This is the West End terminus of the old London, Brighton, and South Coast Railway and of the old London, Chatham, and Dover Railway. Charing Cross is the West End terminus of the old South-Eastern Railway, and Cannon Street, not far from the Mansion House, is the City terminus. Holborn Viaduct is the City terminus of the old

London, Chatham, and Dover Railway, and London Bridge is the City terminus of the London, Brighton, and South Coast Railway. From London Bridge terminus it is about half a mile across the river to Fenchurch Street, the terminus of the old **London, Tilbury, and Southend** Railway, which is now part of the **London, Midland, and Scottish** system.

Note on Railway Grouping.

The chapters on Traffic and Transport were originally written while the grouping of the railway systems was still under discussion.

The student will find it an excellent exercise to work out the reasons for the inclusion of the different lines in the new groups.

The New Railway Groups and the chief former systems they include are as follows (see fig. 61):—

(1) Great Western	Great Western (G.W.R.). Midland and S.W. Junction. Cambrian.
(2) London, Midland, and Scottish	London and North-Western (L.N.W.R.). Midland (M.R.). Caledonian (C.R.). Glasgow and South-Western (G.S.W.R.). Lancashire and Yorkshire (L.Y.R.).
(3) London and North-Eastern	Great Eastern (G.E.R.). Great Northern (G.N.R.). North-Eastern (N.E.R.). Great Central (G.C.R.). North British (N.B.R.).
(4) Southern	London and South-Western (L.S.W.R.). London, Brighton, and South Coast (L.B.S.C.R.). South-Eastern and Chatham (S.E.C.R.).

CHAPTER XVIII

TRAFFIC AND TRANSPORT (*continued*)

Some Studies in English Railways.—A branch of the **London and North-Eastern** Railway was mentioned in the introductory chapter. It serves a flat, agricultural country, and is almost free from the need of tunnelling. The four railways to the north have to cross the Chalk hills, and here long slopes and some tunnels are necessary, one of the longest of the latter being the Watford tunnel of the main line from Euston. All these lines cross the Clay Vale after leaving the Chalk hills, one through Biggleswade, one through Bedford, one through Leighton Buzzard and Bletchley, and a **London and North-Eastern** Railway line through Aylesbury. As pointed out in Chapter I., they now pass across the line of Jurassic hills, which necessitate more deep cuttings or tunnels or the use of gaps. The line from King's Cross has least trouble because it crosses a low part of the Jurassic escarpment between Peterborough and Grantham. The St Pancras main line has cuttings at Wellingborough, Kettering, and Market Harborough. The Euston line has long, deep cuttings at Roade and near Rugby, and a tunnel at Weedon. The Marylebone line has a long tunnel at Charwelton, north of Woodford. It should be noticed that the line from Euston —the earliest to be constructed—follows fairly well the watershed between the rivers of the Wash and the rivers flowing to the south-west, and therefore avoids the necessity of bridging many rivers. The Romans chose nearly the same route for their great road, which was afterwards known as the Watling Street.

The **Great Western** main line to South Wales follows the

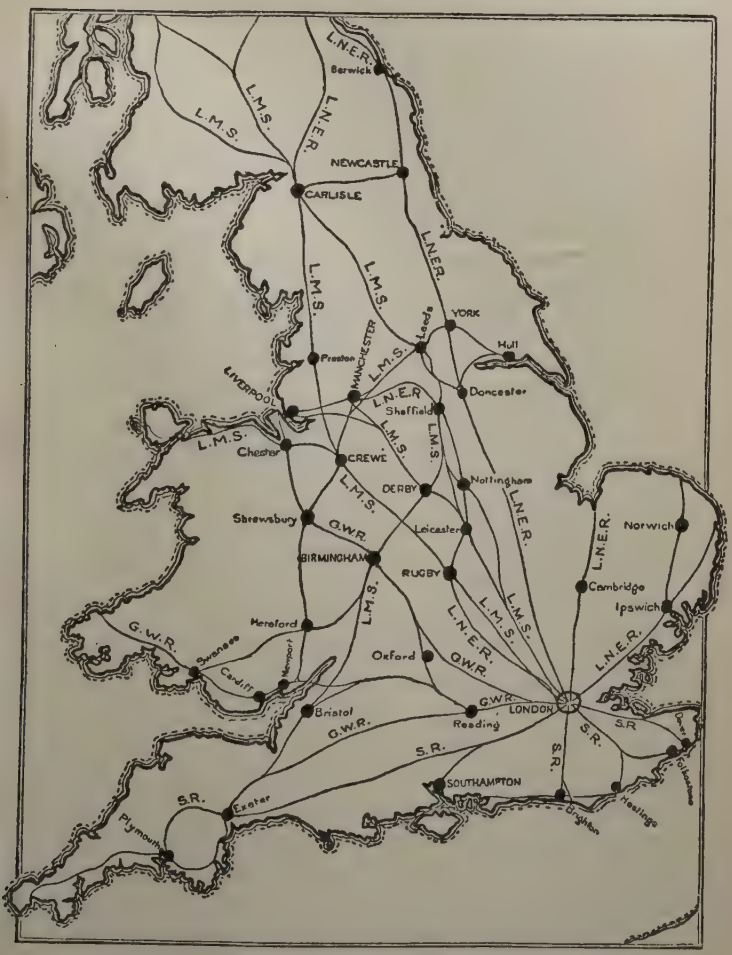


FIG. 61.—RAILWAYS OF ENGLAND, SHOWING THE CHIEF NODAL TOWNS.

For grouping arrangements see table on p. 199.

flat lands of the Thames from London to Reading. Beyond

Reading it uses the Goring Gap to the neighbourhood of Wallingford. At Didcot it turns off along the Vale of the White Horse, following the Ock, a tributary of the Thames. Beyond Swindon it cuts through the Cotswolds to reach the Severn, under which it passes by a tunnel over four miles in length. Let us also follow the Great Western main line to Plymouth. From Reading to the west it follows the river Kennet through the Tertiary Vale of Newbury, and beyond

FIG. 62.—SOUTH-WESTERN ENGLAND.

Showing how the main railway lines cross at Exeter and pass round Dartmoor to reach Plymouth.

Hungerford it passes across the interesting Vale of Pewsey. Beyond this it crosses the Fenlands of Somersetshire, and an interesting name of a small station is seen, Athelney, which links together the old and the new in English history. At Exeter this main line crosses a main line of the **Southern** Railway, and afterwards goes round the *southern* side of Dartmoor, through Newton Abbot and Totnes to Plymouth. It will be convenient at this point to follow the main line of the **Southern** Railway beyond Salisbury. This uses the Vale of

Wardour in the same way that the Great Western uses the Vale of Pewsey. At Exeter it crosses the **Great Western** as mentioned above, and then goes round the *northern* side of Dartmoor, through Crediton and Okehampton to Plymouth. This interesting fragment of railway geography is shown on the diagram map, fig. 62.

The railways of South London have to cross the North Downs to get to the Weald country. This is done by using river gaps such as those of the Wey and the Mole, or by long tunnels as at Woldingham and Sevenoaks. One branch of the **Southern** Railway runs along the vale immediately in front of and parallel to the scarp of the North Downs. It runs for miles in an almost straight line, and connects Guildford and some of the gap towns of Surrey with Tonbridge and Ashford in Kent.

Routes into Scotland.—We now turn to the three routes from London to Scotland. (See fig. 61.)

(*a*) "**The East Coast Route**" from London to Edinburgh is over the lines of three former companies, the **Great Northern,** the **North-Eastern,** and the **North British,** now parts of the **London and North-Eastern** Railway. The trains start from King's Cross and run through Peterborough, Grantham, and Newark to Doncaster. The route then passes across the fen-lands of the Ouse to Selby and thence to York. The Yorkshire Plain is followed northwards to Darlington, and here is one of the straightest and most level lengths of railway line in Britain; from a little north-west of York to beyond Thirsk is a straight run of about twenty-four miles. The line crosses the Tees before reaching Darlington, and from that town continues across the Magnesian Limestone for a dozen miles or so. It now passes on to the Coal-field, and crosses the Wear and later passes Durham. At Gateshead and Newcastle it crosses the Tyne, and continues on the Coal-field almost to Alnwick. It is near the coast in north Northumberland and reaches Berwick. The route enters Scotland,

and a journey is made, partly close to the coast, partly inland, through Dunbar to Edinburgh.

(*b*) The second route is that of the former **Midland** Railway and its Scottish connections. From St Pancras the trains proceed through St Albans and Luton to Bedford. After crossing the Clay Vale, in which the Great Ouse meanders its way, the Northampton Heights are crossed and Leicester is reached. Now the train is on the Midland Plain, which is followed to Trent Junction. After crossing the Trent the train soon enters the Coal-field and continues along the eastern spurs of the Pennines through Chesterfield and Sheffield to Leeds. After Leeds the train follows the Aire Valley to beyond Skipton; here it is passing through the Craven Gap. At Settle it begins to climb up the Ribble Valley on to a plateau of the Northern Pennines. The line tunnels through Blea Moor, one of the spurs of Whernside, and then keeps to the watershed between the Swale and Ure and Lune drainages. It now enters Upper Edendale, and continues past Appleby to Carlisle. After Carlisle two routes may be used: To Edinburgh over the Waverley Route of the **London and North-Eastern** Railway; to Glasgow by the **London, Midland, and Scottish** route past Dumfries, up Nithsdale, over the Uplands, and past Kilmarnock to the destination.

(*c*) The third route is known as the **West Coast Route,** but the journey is almost entirely inland. The **L.M.S.** Scottish expresses start from Euston, and follow the main line through Rugby and Stafford to Crewe. The trains now cross the Cheshire Plain to Warrington, where the Mersey and the Ship Canal are crossed. From here to Wigan and on to Preston the route is through a part of busy industrial Lancashire. After Preston the line follows the plain and keeps quite close to the western edge of the Bowland Fells to Lancaster. It now follows the inner curve of Morecambe Bay to the junction with the former Furness Railway at Carnforth. A little beyond

Carnforth begins the crossing of the Shap Fells, beyond which the train descends to Penrith and to Carlisle. After Carlisle most of the through traffic is taken by a railway which follows the Annan, past Moffat, and crosses the Southern Uplands to Carstairs Junction, from which trains run north-east to Edinburgh and north-west to Glasgow. The relation of these Scottish lines to the English main lines is shown on the diagram map, fig. 65.

Some Important Branch Lines.—The *main* lines of the great companies have been indicated; all the companies have, in addition, some branch lines which are so important that they may rank as Secondary Main Lines: a few examples will suffice.

The **London, Midland, and Scottish** has a great focus at **Crewe,** and from there three secondary main lines branch out from the trunk line. (i) The Irish Mail Route is from Crewe to Chester and along the coast of North Wales, then across Menai Strait and Anglesea to Holyhead. (ii) An important line joins Crewe to Stockport and Manchester, and crosses the Pennines to Huddersfield and Leeds. (iii) A third important line goes from Crewe to the south-west, *via* Whitchurch, Shrewsbury, and Craven Arms to Caermarthen in South Wales. Another cross-country secondary main line connects **Derby** with Stockport and Manchester through the beautiful dales of Derbyshire; a second connects Derby with Burton, Lichfield, Birmingham, Gloucester, and Bristol. These must serve as examples; the reader will be able to trace others belonging to the other great companies.

Important Loop Lines.—In many cases a branch line leaves a main line to connect up an important town or district, and returns to the main line again at some other point. Two examples are given. From **Rugby** a branch line leaves the main line from Euston for Coventry, Birmingham, and Wolverhampton, to rejoin the main line at Stafford. From

Roade another branch line goes off to Northampton, and from this town an extension to Rugby completes another important loop. Thus Rugby is an important focus or nodal point on the London, Midland, and Scottish system. A similar example on the main line from St Pancras may be left to the reader.

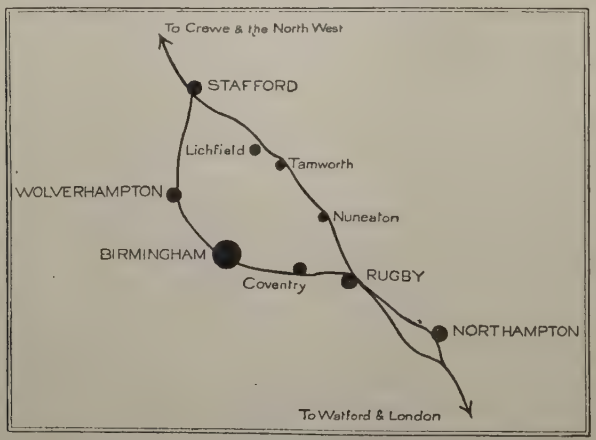


FIG. 63.—LOOPS OF THE LONDON, MIDLAND, AND SCOTTISH RAILWAY, OF WHICH RUGBY IS THE NODE.

Cross-Country Lines.—We have seen that the main lines are directed towards **London,** and the secondary main lines start out from the great foci such as **Derby** and **Crewe.** There are some lines, however, which cut right across the main line systems. One of the most easily traced is the **London, Midland, and Scottish** line from **Cambridge** to **Oxford,** following the Clay Vale diagonally across England. It connects the **London and North-Eastern** Rly. at Cambridge with the **Great Western** at Oxford, and cuts across no less than four main lines. It would be a very slow journey to travel from Cambridge to Oxford by this line; and the traveller would be well advised to journey by the main line to Liverpool Street, cross London,

and journey by a **Great Western** express from Paddington to Oxford.

There are many important main lines which do not connect to London directly; many North of England important lines may be mentioned as examples. The **London and North-Eastern** Railway serves the East and North Ridings of Yorkshire and the counties of Durham and Northumberland. Its main line from near Doncaster to Berwick has already been mentioned. It sends off branches towards the Pennines; one of these crosses the moorlands at a considerable altitude to connect Darlington with Penrith on the London, Midland, and Scottish system. Another line serves Wensleydale, and connects with the main line from St Pancras at Hawes and Hawes Junction. A third line to the west goes through the Tyne Gap, and connects Newcastle with Carlisle. The former **Lancashire and Yorkshire Railway** served a good deal of South Lancashire and a considerable part of the West Riding of Yorkshire. Its main line connects Liverpool, Wigan, Bolton, Bury, Rochdale with Wakefield and Normanton. Important lateral lines connect Manchester, Oldham, Preston, Blackburn, Accrington, and Burnley with the main line on the Lancashire side of the Pennines, and Halifax, Bradford, Leeds, and Huddersfield on the Yorkshire side. On both sides of the Pennines, but more especially in East Lancashire, the various lines of this system interlace and cross each other and make loops in many directions.

Crossing Mountain and Moorlands.—We have already met with some examples; it may be advisable to discuss two typical instances very briefly. The Northern Pennines have few railways, and only one that really crosses from east to west; this is the **London and North-Eastern Railway** branch from Darlington to Penrith already mentioned. The Southern Pennines are crossed by no less than four important lines, even without taking into account the main line through the Craven Gap. The four lines are: **London, Midland, and**

Scottish: (*a*) from Manchester by Rochdale and Halifax to Bradford and Leeds, (*b*) from Manchester through Huddersfield to Morley and Leeds, (*c*) from Manchester by Stockport and Chinley to Sheffield. **London and North-Eastern:** the former **Great Central** line connecting Sheffield by Penistone and Hyde to Manchester. Note that these four important lines converge on **Manchester.**

The Southern Uplands of Scotland are crossed by four main lines: the coast route from Berwick to Edinburgh; the line from Carlisle to Edinburgh (the Waverley Route); the main line from Carlisle to Carstairs Junction; and the western main line from Carlisle to Glasgow *via* Dumfries and Kilmarnock. The great expresses rush across these thinly peopled uplands bearing a great volume of traffic for the industrial region of the Lowlands.

Railway Services of Great Cities.—We have seen that London has termini of all the great trunk lines. Many other important cities have termini or through-traffic stations of several companies which bid for a share of their traffic. **Birmingham** is served by two of the great companies—the Great Western and the London, Midland, and Scottish. **Liverpool** has three termini—two of the London, Midland, and Scottish and one for the Cheshire Lines. The station of the latter allows London and North-Eastern trains to reach the great Mersey port. **Manchester** has four great stations—London Road is used by the London, Midland, and Scottish and the London and North-Eastern; the Central Station is used by the London, Midland, and Scottish, the London and North-Eastern, and the Cheshire Lines trains; Exchange is a terminus and a through station for the London, Midland, and Scottish; and Victoria is also a great terminus and through station of the London, Midland, and Scottish.[1] **Leeds** is very well served by railways; the London, Midland, and Scottish, and the London and North-Eastern have their termini

[1] Victoria and Exchange Stations are now joined.

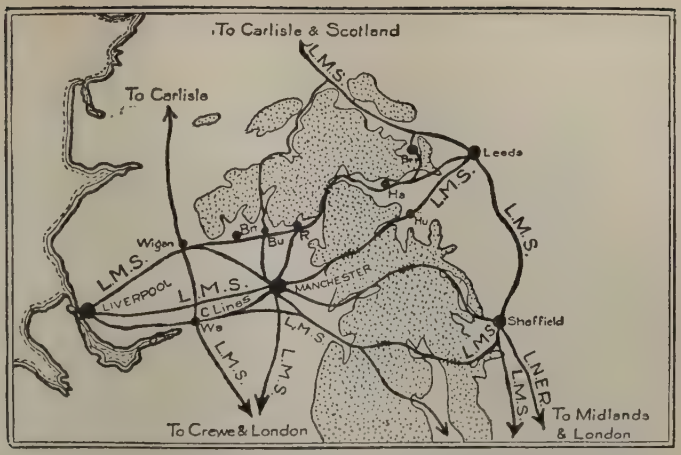


FIG. 64.—RAILWAYS OF THE SOUTHERN PENNINES, CONNECTING FOUR GREAT CITIES OF THE NORTH.

Land over 600 feet is shown by stippling.

FIG. 65.—THE CHIEF RAILWAYS OF THE SOUTHERN UPLANDS AND THE CHEVIOTS.

Land over 600 feet is shown by stippling.

and stations for through traffic; expresses run from Leeds to London by both the London, Midland, and Scottish and two of the London and North-Eastern Railway routes.

In connection with North Country traffic one series of expresses which plays an important part may be quoted. These through trains run between **Liverpool** and **Hull**; from Liverpool to Leeds they run on the London, Midland, and Scottish system *via* Manchester and Huddersfield. At Leeds New Station the London and North-Eastern takes charge, and the trains proceed to Hull *via* Selby. The stops are usually at the towns mentioned: Manchester, Huddersfield, Leeds, and Selby.

The Seas.—The British Isles, with the greatest relative import and export trade in the world, are particularly interested in travel and transport by sea. There are many obvious reasons why British ports are of such great importance. About four-fifths of the food and a large proportion of the raw materials used in manufactures are imported; and manufactures have to be exported in exchange for raw materials and food. A glance at some raw materials shows the utter dependence upon shipping; the British Isles import over three-quarters of the **wool** used, all the **cotton,** 80 per cent. of the **flax,** all the **hemp and jute,** all the **rubber,** practically all the **asbestos,** nine-tenths of the **copper,** very nearly all the **gold,** 95 per cent. of the **silver.** It is at once seen what an important part shipping must play. Fortunately, there are facilities for import and export probably superior to those of any other region in the world. Estuaries and other suitable openings are distributed almost all round the coast; tides are high, and the waves penetrate far inland; no part of the islands is far away from a good port; the islands are near to the continent of Europe, and they face the busy side of North America; they are almost in the middle of the land surfaces of the globe—that is, no other region is so near to as much land; and the river-mouths and other ports are never closed by ice.

All this means that there are regular sailings, some to the most distant parts of the world, some dealing with traffic in the British Isles and the neighbouring lands. The latter

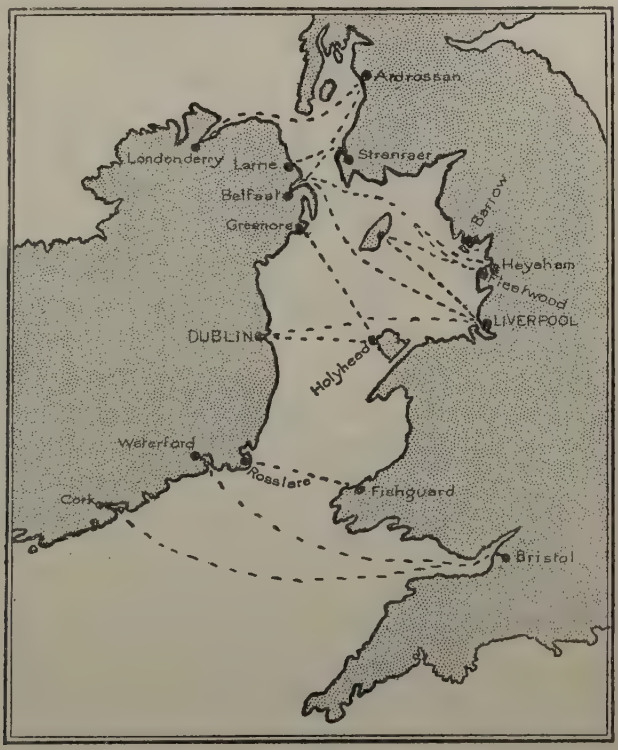


FIG. 66.—STEAMSHIP ROUTES ACROSS THE NORTH CHANNEL, THE IRISH SEA, AND ST GEORGE'S CHANNEL.

may be mentioned first. Glasgow, Liverpool, and Bristol, among the greater ports, have regular sailings to Ireland, connecting with Londonderry, Belfast, Dublin, and Cork, and some of the lesser Irish ports. There are also special ports which deal with lighter goods traffic and with passenger traffic, and with some coal shipments. Of these Ardrossan-

Londonderry, Stranraer - Larne, Heysham - Belfast, Fleetwood-Belfast, Holyhead-Greenore, Holyhead-Dublin (Kingstown), Fishguard-Rosslare, are well-known routes. The great railway companies make special arrangements for

FIG. 67.—STEAMSHIP ROUTES ACROSS THE ENGLISH CHANNEL AND THE NORTH SEA.

boats and trains, and for quick transit generally by these pairs of ports.

It is so, too, with the nearer parts of the Continent: pairs of ports are associated in their traffic. Some of these are: Weymouth-St Malo, Southampton-Havre, Newhaven-Dieppe, Folkestone-Boulogne, Dover-Calais, Dover-Ostend, Harwich-Hook of Holland, Hull-Zeebrugge, Hull-Bergen and Leith-Bergen.

The great ports deal with all the world, though naturally

Liverpool does more trade with North America relatively than does **Hull**, while the latter will obviously attract more of the traffic from the Baltic and Scandinavia than does the great Mersey port. **Bristol** has always had considerable trade with the West Indies and South America ; while **Southampton** has always taken a large share of South African traffic. **London** has ships for everywhere and from everywhere, and has consequently the most varied import and export trade in the world **London** has the greatest tonnage; **Liverpool** comes next in that respect; and the claim for third place provides room for argument through the changing years. Glasgow, Bristol, Hull, and Manchester have all made claim to the honour during recent years.

CHAPTER XIX

LONDON

LONDON, the capital of England, the metropolis of the Empire and the greatest city in the world lies on both banks of the River Thames, fifty miles from its mouth. The name London is used to denote both the small, ancient **City of London** and the **County of London** which contains the City of Westminster and 27 boroughs as well as the City of London. (See map, p. 222.) In addition there is "**Greater London**" which includes the whole of the counties of London and Middlesex together with parts of Kent, Surrey, Essex, and Herts. The **City of London** lies between the Tower on the east and Temple Bar on the west. It is very little over a square mile in area, and contains a resident population of little more than 10,000; though during an ordinary business day there must be almost half-a-million people engaged there. It is ruled by the Lord Mayor, Aldermen, and the Court of Common Council. The **County of London** is under the rule of the London County Council: it embraces an area of 117 square miles, and has a population of $4\frac{1}{2}$ millions. (See note at end of chapter.) "**Greater London**" is the area under the charge of the Metropolitan and City Police: it covers 690 square miles, and has a population of more than 8 millions.

The position of London was marked as important even in pre-Roman times, for there was a fortified British camp which bore the name Linndun. This was on a steep bank of the Thames overlooking the lagoons bordering the winding river; the Tower of London probably occupies almost the same position. In Roman times it was a meeting-place of traders, and was of considerable importance.

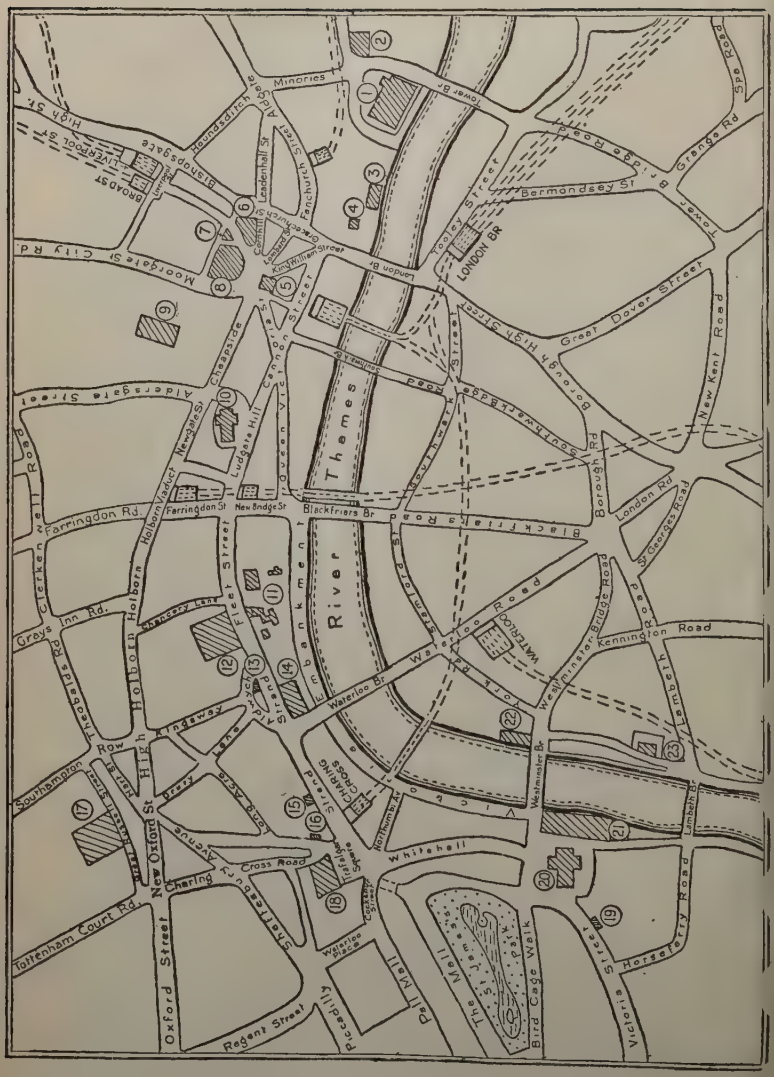
When the Roman rule had broken down and the internal

struggles of the Anglo-Saxons kept the country in a state of unsettlement for centuries, London was often able to take its stand as a small independent state. When William the Norman conquered southern Britain he made a treaty with the Londoners, and soon gave them a charter. From that time onward London became the assured capital: it rapidly went ahead, and has continued to be the first of British cities.

There were two fords—one not far from the present St Paul's and one at Westminster. When **London Bridge** was built in 1170, it soon replaced the City ford, and became the centre of London's intercourse. The Watling Street (now Edgware Road) aimed at the Westminster ford; now the traffic turned off along the present Oxford Street and aimed at the Bridge, and there is thus a Watling Street in the City, close by St Paul's Cathedral. The Bridge was situated at the head of the estuary, and almost at the head of the tidal navigation; hence it became the point of transhipment between sea-borne and river-borne traffic. London below the Bridge grew into a great port; London round the Bridge became a great place of interchange of productions.

When intercourse between England and the Continent increased, the position of London opposite the busy mouths of the Scheldt and the Rhine gave it further advantages; and later, when the epoch of Continental trade was absorbed in that of the world trade in the sixteenth and seventeenth centuries, London's supremacy was so well established that the City, the port, and the rapidly extending suburbs became the greatest meeting-place of traders the world had ever seen. The influx of skilled artisans from the Continent, due to the frequent wars and persecutions, the readiness of London to absorb various elements of trade and finance, added to its prosperity; the modern enterprise of its merchants has continued the tradition; and London is now the greatest trading and financial centre of the world.

London is the capital of England, the capital of the United


Tower Br.
Minories
Aldgate
Houndsditch
Leadenhall St.
Fenchurch Street
Bishopsgate
Broad St.
Liverpool St.
High St.
Moorgate St
City Rd
Tooley Street
LONDON BR
Bermondsey St
Grange Rd
Thames
River
Great Dover Street
Borough High Street
New Kent Road
Southwark Bridge
Southwark Bridge Road
Queen Victoria St.
Cannon St.
King William Street
London Br.
Gracechurch St.
Lombard St.
Cornhill
Poultry
Cheapside
Aldersgate Street
Clerkenwell Road
Farringdon Rd.
Farringdon St.
New Bridge St.
Blackfriars Br.
Blackfriars Road
Borough
London Rd
St. Georges Road
Newgate St.
Holborn Viaduct
Ludgate Hill
Fleet Street
Embankment
Victoria Embankment
Waterloo Br.
Waterloo Road
Westminster Bridge Road
Kennington Road
Lambeth
Greys Inn Rd.
Theobalds Rd.
Holborn
Kingsway
Aldwych
Strand
Waterloo Place
Trafalgar Square
Charing Cross
Whitehall
Westminster Br.
Victoria Embankment
Lambeth Br.
Southampton Row
High Holborn
New Oxford St.
Oxford Street
Tottenham Court Rd.
Cranbourn Street
Leicester Square
Coventry St.
Haymarket
Regent Street
Piccadilly
Pall Mall
The Mall
Bird Cage Walk
Victoria St.
Horseferry Road

Key to chief Buildings.—1. Tower of London. 2. The Mint. 3. The Custom House. 4. The Monument. 5. The Mansion House. 6. The Royal Exchange. 7. The Stock Exchange. 8. The Bank of England. 9. The Guildhall. 10. St Paul's Cathedral. 11. The Temple. 12. The Law Courts. 13. Australia House (Commonwealth of Australia). 14. Somerset House. 15. High Commissioner for Dominion of New Zealand. 16. High Commissioner for Union of South Africa. 17. The British Museum. 18. The National Gallery. 19. High Commissioner for Dominion of Canada. 20. Westminster Abbey. 21. Houses of Parliament. 22. London County Hall. 23. Lambeth Palace.
The width of the streets is exaggerated so as to print the names along them.
Note for Scale.—From Trafalgar Square to the end of Chancery Lane is about a mile.

Kingdom, the capital of the British Commonwealth. It is the meeting-place of the British Parliament and seat of the Government. The **Houses of Parliament** are situated in Westminster, on the banks of the Thames, near the place where the old road through Kent met the Watling Street at Westminster Ford. The **Government Offices** are mostly in Whitehall—a fine street leading almost due north from Westminster Hall to Trafalgar Square. The **Law Courts,** where the law is administered, are at the eastern end of the Strand; the Temple, where the law is studied, is not far away; Somerset House, where a great deal of administrative work connected with certain branches of law is centred, is on the south side of the Strand. The headquarters of the **Post Office** and the National Telephones are in the City. The great "Dominion Houses," dealing with the affairs of the self-governing Dominions, are situated mainly in the neighbourhood of the Strand and Charing Cross.

London is a great centre for various forms of **educational activity.** The London County Council has its own vast education department dealing mainly with primary and various forms of secondary and continuation education. The **University of London** has its headquarters at present in the Imperial Institute at South Kensington. The University is a famous examining body, and examines vast numbers of students not only from the United Kingdom but also from many parts of the British Dominions. There are affiliated with it many colleges situated in different parts of London. There

are a number of training colleges for teachers also scattered over Greater London. The **British Museum,** the **Victoria and Albert Museum,** the **Natural History Museum,** are among the finest museums in the world, and contain priceless collections of various kinds: there are many other museums of less importance. The **Imperial Institute** contains collections of mineral, vegetable, animal, and manufactured products from all parts of the British Empire. The London **Art Galleries** contain magnificent exhibits of pictures and sculpture. The **Zoological Gardens** in Regent's Park have a very fine collection of animals from all parts of the world, though some of the animals are now kept in the Zoological Park at Whipsnade, 34 miles from London. The Opera House in Covent Garden, the Royal Academy of Music, the Royal College of Art, the headquarters of the learned societies, such as the Royal Society, the Geological Society, the Royal Geographical Society, and many more, are other forms of educational activity located in London.

London is a great financial centre. The **Bank of England** has its headquarters in the City; and every important bank, not only of the United Kingdom, but of the whole world, has a branch in London. The **Royal Mint** and the **Royal Exchange** are both in the City.

As already indicated, London is a vast trading centre. The river and its shipping, and the great railways which converge on London, are busily engaged in bringing and distributing a wonderful miscellany of products of trade and commerce. The Regent's Canal and the Surrey Canal, which lead to the docks, help in this great trade. There is a series of **docks,** extending from the eastern end of the City for about twenty miles down the river. London imports almost everything the world supplies, and ships of every flag are seen in the river and the docks. In consequence of this London has some famous sales and contains large and important markets. The **wool sales** of London deal with wool from the great exporting

lands of the Southern Hemisphere, as well as with wool from Russia, the United States, and Canada. The "**Tea Market**" in Mincing Lane, the Hop Exchange, the **Fish Market** at Billingsgate, the **Meat Market** at Smithfield, and the **Fruit**

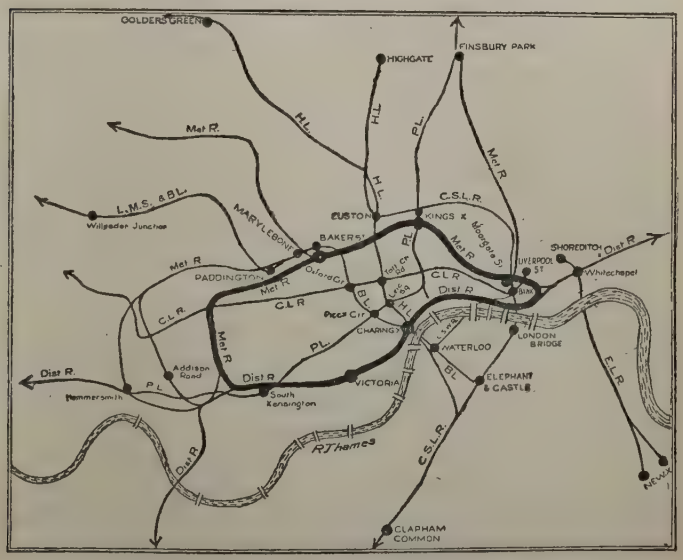


FIG. 69.—UNDERGROUND RAILWAYS OF LONDON.

The "Inner Circle" of the Metropolitan and District Railways is shown by a thicker line.

Key to Abbreviations.—Met. R., Metropolitan Railway; Dist. R., District Railway; E.L.R., East London Railway; C.L.R., Central London Railway; C.S.L.R., City and South London Railway; P.L., Great Northern, Piccadilly and Brompton Railway; B.L., Baker Street and Waterloo Railway; H.L., Charing Cross, Euston and Hampstead Railway. Compare with figs. 60 and 68.

Note for Scale.—From Oxford Circus to Liverpool Street is almost exactly 3 miles.

and Vegetable Market at Covent Garden are well-known London institutions.

London as a great railway centre has already been mentioned. Most of the great railway lines converge on London, and the termini are connected with each other and to various parts of London by an extensive system of underground railways. (See fig. 69.) Trains run at very frequent intervals round

what is known as the Inner Circle. Some important and familiar places on the circle are: the Mansion House, Liverpool Street, King's Cross, Baker Street, Edgware Road, South Kensington, Victoria, Westminster Bridge, Charing Cross, and the Temple. There is also a network of **"Tube Railways"** on which is run a frequent service of electric trains serving the City, the West End, South London, and the suburbs. The traffic of London is so enormous that in 1933 Parliament appointed a special authority called the London Passenger Transport Board to organise and control the whole system of public transport —trams, buses, tubes, and trains—in the area of Greater London.

London is one of the greatest manufacturing centres in the world, but there is no great outstanding trade, as there is at Manchester, Birmingham, or Sheffield. Some reference to the manufactures has been made in earlier chapters; a further brief mention is all that is now necessary. The south-east, the east, the north, and certain of the suburbs are the great manufacturing districts of Greater London. In a list of the chief productions the first place may well be given to **food products,** of which London makes enormous quantities, including flour, biscuits, cakes, confectionery, sweets, jams, marmalade, pickles, relishes, vinegar, and mustard. **Sugar-refining** is a great industry, and sugar, treacle, and syrup are produced. The **clothing trade** has been mentioned already: it includes underclothing, costumes, blouses, men's suits and overcoats, hats, caps, gaiters, uniforms, motor clothing, handkerchiefs, ties, mufflers, gloves, and millinery. There is a great **leather tannery** industry in South-east London (Bermondsey and Rotherhithe), and both light and heavy leather are produced. Some of this is made up in London into leather coats and caps, boots and shoes, belts, leather bags, fancy leather goods, and much is used for bookbinding and in the furniture trade. The **chemical industries** of

London are very considerable, and include manures, antiseptics, disinfectants, medicinal chemicals, scents, photographic chemicals, polishes, oils, paints, varnishes, and soap. The manufacture of matches is another well-known London industry. **Timber** is imported into London from many parts of the world, and the industries connected with timber are among the most important of London's manufactures. Furniture of various kinds, for home and office, for school and college, for hotels and public halls, is made in Hoxton, Haggerston, and adjacent districts. Wood boxes are also produced in enormous quantities. There is little manufacture of **paper** in London; but industries in paper include the making of cardboard boxes, envelopes, notepaper, postcards, writing-blocks, note-books, and exercise-books. There is an immense **printing, bookbinding, and publishing** industry carried on in London. **Metal work** of various kinds, from fine work such as the making of watches and delicate chemical balances to that of big dynamos, gas engines, motor cars and motor wagons, is carried on in several London districts. Brushes, linoleum, household utensils of various kinds, toys, ornaments, picture-frames are among the London productions. It would be difficult to exhaust the list; enough has been said to show the variety and extent of London's manufactures.

A Note on the County of London.

The **County of London** comprises the City of London and twenty-eight metropolitan boroughs. The area of the City of London is very slightly over one square mile, and the population, at the census of 1931, was 10,996, the whole County of London has an area of 117 square miles, and its population in 1931 was nearly four and a half millions.

The twenty-eight metropolitan boroughs are: City of Westminster, Battersea, Bermondsey, Bethnal Green, Camberwell, Chelsea, Deptford, Finsbury, Fulham, Greenwich, Hackney, Hammersmith, Hampstead, Holborn, Islington, Kensington

(Royal Borough), Lambeth, Lewisham, Paddington, Poplar, St Marylebone, St Pancras, Shoreditch, Southwark, Stepney, Stoke Newington, Wandsworth, Woolwich.

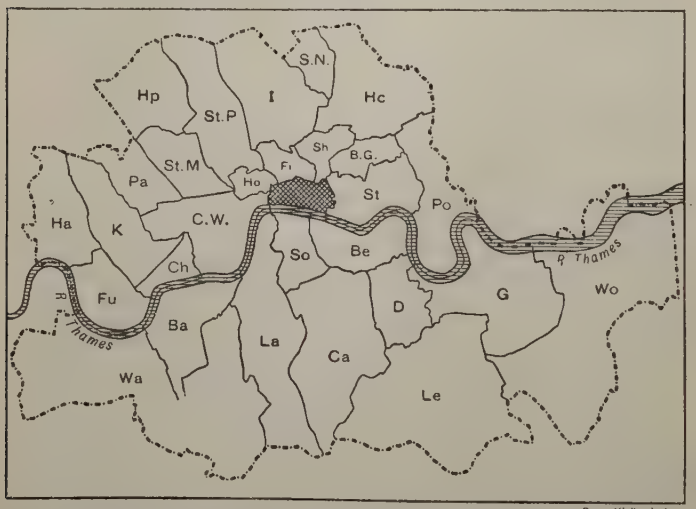


FIG. 69A.—A DIAGRAM-MAP OF THE COUNTY OF LONDON, SHOWING THE BOROUGHS AND THE CITY OF WESTMINSTER CONTAINED IN THE COUNTY.

C.W. City of Westminster; *Ba.* Battersea; *Be.* Bermondsey; *B.G.* Bethnal Green; *Ca.* Camberwell; *Ch.* Chelsea; *D.* Deptford; *Fi.* Finsbury; *Fu.* Fulham; *G.* Greenwich; *Hc.* Hackney; *Ha.* Hammersmith; *Hp.* Hampstead; *Ho.* Holborn; *I.* Islington; *K.* Kensington; *La.* Lambeth; *Le.* Lewisham; *Pa.* Paddington; *Po.* Poplar; *St. M.* St Marylebone; *St.P.* St Pancras; *Sh.* Shoreditch; *So.* Southwark; *St.* Stepney; *S.N.* Stoke Newington; *Wa.* Wandsworth; *Wo.* Woolwich.

The City of London is shown by crossed lines.

CHAPTER XX

THE INDUSTRIAL AREAS OF BRITAIN

The British Isles are industrial and likely to remain so. There is a big population to feed—people with high-earning capacity, needing and demanding good and varied food. There must, therefore, be a very big import of food and raw materials. To purchase these imports manufactured goods must be produced in excess of the needs of the British people ; for imports must be bought either by exports of manufactured goods or of British coal. The great manufactures are carried on in certain well-defined regions, the *chief* factor determining the locality being coal ; but water supply, the supply of raw materials, and facilities for transport are other important considerations.

Most of the great industrial areas of Britain have been mentioned already in the chapters dealing with special industries, and in the chapter on transport. In this chapter the great industrial areas, in which are congregated the great masses of the population, are considered separately, though of necessity very briefly.

The Industrial Area of the Scottish Lowlands.—Scotland contains nearly five millions of people ; about four millions live in the Lowlands. These Lowlands lie between two comparatively infertile regions—the Highlands and the Southern Uplands, which are very sparsely peopled.

The soil of the Lowlands is, on the whole, fertile ; but the great factor which has brought together so many people is the wealth from the rocks of the Carboniferous System (see

pp. 21, 154). The **coal** of the three coal-fields comes first; in addition there is obtained a good deal of **black-band ironstone;**

FIG. 70.—THE CHIEF INDUSTRIAL REGIONS OF THE BRITISH ISLES.

Note.—It will be a useful exercise for the reader to work out what industries are connected with each region shown, and what are the chief industrial towns concerned.

and not far away **limestone** is found in large quantities. These three things, it will be remembered, are necessary for smelting **iron;** hence the development of **iron-smelting,** and the

engineering industries dependent thereon. From the Carboniferous System are also obtained the " oil shales," from which are produced large quantities of burning oils, solvent oils, solid paraffins, and ammonia. In the same great system are abundant shales from which are made bricks, tiles, and sanitary ware. Finally, there is plenty of good building stone, both in the Carboniferous and the Old Red Sandstone Systems.

The Lowlands are penetrated by three great estuaries, into which flow the three most important Scottish rivers—the Tay, the Forth, the Clyde.

Remembering these factors, we should be able to understand the importance of the following industries:—coal-mining; shale-quarrying and mining; iron-ore mining; stone quarrying; coke-making; iron-smelting and general engineering; the vast shipbuilding and marine engineering of the Clyde; chemical industries; and the textile industries of Glasgow and Paisley, of southern Fifeshire, and of Dundee and district. There is sugar-refining in the Clyde region, and dependent on it are the jam, marmalade, and sweets industries of Glasgow and Paisley. There are similar manufactures at Dundee on the other side of the great industrial area. To these may be added the flour-milling and the biscuit manufactures of both Edinburgh and Glasgow. Finally, without pretending to exhaust the list, we should not overlook the paper, printing, and bookbinding trades of Edinburgh.

The chief towns in this industrial province are the following[1] (the reader should locate them on a good map):—Edinburgh (the capital of Scotland), 439,000; Glasgow, 1,088,500; Dundee, 175,000; Paisley, 86,000; Greenock, 79,000; and Dumbarton, Ayr, Kilmarnock, Clydebank, Renfrew, Rutherglen, Airdrie, Coatbridge, Motherwell, Hamilton, Falkirk, Stirling, Perth, Dunfermline, Kirkcaldy, St Andrews, Arbroath.

[1] The figures give their population according to the 1931 census.

The North-Eastern Industrial Area.—This well-defined area occupies the south-eastern part of Northumberland, the eastern half of Durham, and the extreme north-east of Yorkshire. The three rivers provide water, carry away the town effluents, and their estuaries provide means of inlet to this busy area. The industrial area coincides very closely with the coal-field, except in the Tees district, where the iron-smelting, engineering, and shipbuilding of Middlesbrough, Stockton, and the Hartlepools are well away from the actual coal-field.

The **coal-mining** of **Newcastle** and district has long been famous, and the coal-field now ranks second in production (*cf.* p. 155). A great deal of coal is exported from the ports. **Coke-making** for iron-smelting is a great industry, and the by-products are used in an important chemical industry. **Iron-smelting** is a vast industry, and the ore of the Coal Measures, and the more important ores from the Cleveland Hills, are supplemented by large quantities imported from Sweden, Norway, Labrador, Newfoundland, Spain, and Greece.

Various forms of **engineering** are highly developed, some of the works on the Tyne being among the most famous in the world. Electrical engineering is an important branch, and marine engineering is obviously to be expected. In shipbuilding, the Tyne, the Wear, and the Tees (grouped as the North-Eastern shipbuilding district) maintain a rivalry with the great output of the Clyde.

In this great industrial area there are congregated at least two millions of people; and the following are the more important cities and towns:—Newcastle, 283,000; Sunderland, 186,000; Middlesbrough, 138,500; Gateshead, 122,500; South Shields, 113,500; and Morpeth, Bedlington, Blyth, Tynemouth (with North Shields), Wallsend, Hebburn, Jarrow-on-Tyne, Stanley, Durham, Bishop Auckland, Darlington, Stockton, West Hartlepool, and Hartlepool.

The Industrial Area of the Eastern Pennines.—This very important industrial area stretches from north of Leeds to

the south-eastern end of the Pennines. It occupies the eastern slopes of the Southern Pennines, overlaps on to the North-eastern Plain, and creeps up the Pennine valleys into the heart of the moorlands. The Carboniferous rocks again occupy most of the area, and the various formations of that important system contribute a good deal of mineral wealth. The Carboniferous Limestone yields abundant **limestone** and lime for various industries; the Millstone Grit supplies excellent **building stone,** and in earlier days furnished millstones and grindstones; the Coal Measures yield fine building stone, shale for **brick-making, iron ore** (clay iron-stone and blackband ore), and at present more **coal** than any other British coal-field. The Sandstones of the Millstone Grit and Coal Measures also give out abundant supplies of pure, soft water.

The industries include the mining of coal and iron-ore, and the quarrying of shale, sandstone, and limestone. Iron-smelting, iron and steel-making, and general engineering are all important. Some of the forms that the engineering takes have already been mentioned; here may be emphasised the making of cutlery and edge-tools at **Sheffield** in addition to its bulky engineering, and also the production of various kinds of electroplated metal goods. Sheffield is a rival of Birmingham in that branch of metal work.

The manufacture of **chemicals** is important, as is also that of leather, soap, glass, and paper. **Leeds** is one of the two greatest **leather** centres in Britain. The district from Rotherham to Castleford is well known for the manufacture of various kinds of **glass** bottles.

The great **wool** industry is located in a comparatively limited part of the West Riding of Yorkshire. At the southern end of the area are the lace and hosiery industries of Nottingham.

The West Riding contains over three millions of people, of whom by far the greater part are in the industrial area. If

we add the population of the industrial parts of Derbyshire and Nottinghamshire, there must be a grand total of well over three and a half millions of people.

The chief cities and towns are the following:—(Yorkshire) —Sheffield, 512,000; Leeds, 483,000; Bradford, 298,000; Huddersfield, 113,500; Halifax, 98,000; and Todmorden, Skipton, Keighley, Bingley, Shipley, Harrogate,[1] Morley, Brighouse, Dewsbury, Batley, Spenborough, Wakefield, Barnsley, Rotherham, Castleford, Doncaster. (Derbyshire) —Derby, 142,500; and Chesterfield, Heanor, Ilkeston, Long Eaton. (Nottinghamshire)—Nottingham, 269,000; and Worksop, Mansfield, Sutton-in-Ashfield, Retford, Gainsborough, and Newark.

The Manchester-Liverpool Industrial Area.—Manchester—sometimes called the Capital of the North—is nearly in the centre of the greatest industrial area in the world. **Liverpool** is the port, and, though the two great cities are separated by a belt of peat-mosses and thinly peopled country, the railway services are so frequent that the connection is a very close one. There is a healthy, keen rivalry between the two cities, and it seems best to regard the great industrial area as led by the two.

As in the other industrial areas already studied, the **coal-field** may be taken as the first great factor, but it is not quite in the front rank of British coal-fields, although 90,000 men and boys are employed in direct connection with coal-mining.

The **shale, fireclay,** and **building stone** of the Coal Measures, the sandstone of the Millstone Grit, the limestone of the Lower Carboniferous, the red sandstone of Runcorn, and the **salt** of Cheshire are other rocks and rock-minerals of great importance. The plentiful water-supply of the Western Pennines and the Rossendale Fells must be given a high place in those factors which have made for the enormous development of this industrial area.

[1] Harrogate is somewhat outside the busy part of the industrial area.

The industries are numerous and varied. Coal-mining; the quarrying of shale, sandstone, and limestone; salt-getting; the making of bricks, tiles, and sanitary ware from shale and clay; the manufacture of both fine and heavy chemicals; and the production of enormous quantities of soap, glass, paper, and some leather, are among the important manufactures.

There is not a great deal of iron-smelting, but **engineering** of various kinds is carried on, and the twin town Manchester-Salford has been described as the greatest engineering centre in the world. Machinery is made for the textile, mining, shipping, chemical, and electrical industries; and locomotives, tramcars, motor cars, motor wagons, and aeroplanes are all made in the district.

The spinning, weaving, bleaching, dyeing, and finishing of **cotton** make up the foremost industry, and the greatest concentrated industry in the world, and a great part of the enormous wealth produced comes from this industry. Other important manufactures are clothing, hats and caps, boots, shoes, leggings and gaiters, slippers, felts, flannels, and blankets, silk goods, incandescent mantles, asbestos goods, motor and cycle tyres.

Finally, there must be mentioned flour-mills; the making of biscuits, jams, and marmalade; oil refining; the making of cattle cake; sugar-refining; making chocolates and sweets; and the production of margarine.

The population is enormous, probably reaching about five millions of people. The number of large and important cities and towns is very great, as the following list will show. (Lancashire)—Liverpool, 855,500; Manchester, 766,500; Salford, 223,500; Bolton, 177,000; Oldham, 140,500; Blackburn, 122,500; Preston, 119,000; St Helens, 107,000; Burnley, 98,500; Rochdale, 90,500; Wigan, 85,500; Warrington, 79,500; Bootle, 77,000; and Chorley, Widnes, Earlestown, Leigh, Eccles, Swinton, Ince, Stretford, Ashton-under-Lyne, Mossley, Chadderton, Middleton, Hindley, Farnworth, Radcliffe, Bury, Heywood, Rawtenstall, Bacup, Todmor-

den,[1] Haslingden, Darwen, Accrington, Nelson, Colne, Clitheroe. (Cheshire)—Chester, 41,500; Birkenhead, 148,000; Stockport, 125,500; Wallasey, 97,500; and Stalybridge, Hyde, Dukinfield, Macclesfield, Crewe. (Derbyshire)—Glossop. (Staffordshire, North)—Stoke-on-Trent, 277,000; Newcastle-under-Lyme, and Burton-upon-Trent, in the counties of Staffordshire and Derbyshire. Southport, Blackpool, and Lytham-St Anne's are holiday resorts and residential towns.

The Birmingham Industrial Area.—This occupies most of South Staffordshire, parts of Warwickshire, Worcestershire, and Shropshire, and sends outliers of its industries into Leicestershire, Northamptonshire, and Oxfordshire.

The great fundamental factor is the **South Staffordshire coal-field** and the coal of Warwickshire and the Severn Valley. Iron-ore in the Coal Measures, the limestone of Dudley and Wenlock, and the coal made possible the development of the once greatest **iron-smelting** industry in Britain. The local ore is, of course, supplemented nowadays by ore from the Jurassic rocks of Leicestershire, Northamptonshire, and Oxfordshire, and by ore from abroad. On the iron and steel industry a great mixed-metals industry has been grafted, which involves the use of much copper, tin, zinc, lead, nickel, antimony, aluminium, silver, gold, and platinum. The list of productions is by no means exhausted by the following:—Jewellery, ornaments, plate, cutlery, general tools, pens, fountain-pens, drawing-pins, metal clips and holders, typewriters, pins, safety-pins, needles, buttons, sewing-machines, locks, keys, door-handles, picture-holders, nails, screws, hooks, electric-switches, taps, fireirons, washers, mangles, gas-boilers, cooking-ovens, brass and iron bedsteads, chains, gas-engines, steam-engines, steam-boilers, dynamos, gas-pipes, water-pipes, scales and weights, spring balances, sales registers, bicycles, motor cars, motor wagons, and aero-

[1] Also given in the Eastern Pennines Industrial Area ; the two areas overlap, and Todmorden may reasonably be claimed by each.

planes. These are sufficient to show the great variety of goods produced.

The population of this area is probably about two and a half millions, and it includes the following cities and towns:—Birmingham, 1,002,500; Coventry, 167,000; Wolverhampton, 133,000; Walsall, 103,000; Smethwick, 84,500; West Bromwich, 81,500; and Cannock, Bilston, Wednesbury, Coseley, Tipton, Dudley, Oldbury, Rowley Regis, Stourbridge, Kidderminster, Lichfield, Sutton-Coldfield, Tamworth, Atherstone, Nuneaton. The following are somewhat outside the busy area, but are closely associated with it in many ways:—Worcester, Wenlock, Bridgenorth, Bewdley, Stafford, and Leamington.

The South Wales Industrial Area.—This busy area occupies part of Monmouth County, the south of Glamorganshire, and part of Carmarthenshire, with outliers in Pembrokeshire on the west and Gloucestershire on the east. The great asset is **coal,** and the South Wales coal-field is the third in yield in Britain (*cf.* page 155). There is much anthracite in addition to ordinary bituminous coal, and this adds to the importance of the coal-field. **Coke-making** for iron-smelting is largely carried on, and the latter industry is very important. The **smelting** of copper, tin, and zinc are also carried on; and the tin-plate trade, and the making of sheet-copper, copper-wire, brass and bronze, are important branches of the metal industries.

More coal is shipped from this area than from any other British coal-exporting district. Some shipbuilding is carried on.

The chief towns are as follows:—Cardiff, 223,500; Swansea, 165,000; Rhondda, 141,500, Newport (Monmouthshire), 89,000; Merthyr Tydfil, 71,000; and Aberdare, Pontypridd, Mountain Ash, Gelligaer, Abertillery, Barry, Port Talbot, Ebbw Vale, Abersychan, Ogmore, Maesteg, Tredegar, Bedwellty, Neath, Llanelly, Carmarthen, Pembroke.

We now come to a description of industrial areas of the second rank, mostly large towns, their immediate suburbs, and a few outlying villages.

Aberdeen, 167,500, as its name indicates, is at the mouth of the Dee, in Eastern Scotland. It is the fourth of Scottish towns in population. Its better known industries are **granite-quarrying** (Aberdeen is often called " The Granite City ") and **fishing.** It sends out many vessels to the whale fisheries. It is the home of one of the four Universities of Scotland.[1]

Hull, 313,500, is the third city in Yorkshire. It is the great port of the Humber, and serves the busy hinterland of the Eastern Pennines Industrial Area. Its industries include **shipping,** shipbuilding and repairing, a great trade in timber with the Baltic and Scandinavia, and the consequent manufacture of many timber products; the making of chemicals, soap, paints and varnishes, wall-paper, and rope and twine. Grimsby, 92,500, and Immingham, across the Humber, in Lincolnshire, may be included in the same industrial area. The former town is the busiest fishing town in the British Isles.

Portsmouth and Southampton.—These may be included as part of one industrial and commercial area. **Portsmouth,** 249,500, is a great **naval station** where all kinds of work in connection with the British Navy are carried on. This is the largest English town south of London. **Southampton,** 176,000, is a great port on a fine inlet. As already explained, it has four tides a day. Its chief industries are in connection with **shipping,** and many great liners make it a port of call. Eastleigh, 18,500, where are the great works of the Southern Railway, is almost a suburb of Southampton. Gosport may be similarly reckoned a suburb of Portsmouth, though it is separated by the narrow entrance to Portsmouth Harbour.

Plymouth, 208,000, **Devonport,** and **Saltash** make practically

[1] The others are Edinburgh, Glasgow, and St Andrews.

one great " town," [1] mainly concerned with merchant **shipping** and the Navy. A good deal of shipbuilding is carried on there. Plymouth Sound is a magnificent harbour, and the great triple town owes much of its prosperity to this fine sound or compound ria. (See fig. 40, p. 109.)

Bristol, 397,000, is a great city on the borders of Gloucestershire and Somersetshire. There is a small **coal-field,** and the river Avon has been made suitable for **shipping.** A few miles away is Avonmouth, where are docks for bigger ships. Bristol and the lower Avon, with Avonmouth, make up one of the great British ports, which has specialised in trade with the West Indies and South America. Its industries include engineering, boot shoe and clothing manufacture, flour-milling, sugar-refining, and the cocoa and chocolate manufacture. Bristol is the home of one of the newer universities of England.

Barrow, 66,500, is a **shipbuilding** town situated at the western end of the Furness part of Lancashire, opposite Walney Island, on which are extensions of the industries of Barrow. It shares with Ulverston, Dalton, Millom, and Askam in a considerable iron-smelting industry (see p. 157).

West Cumberland.—This industrial area includes Whitehaven, 21,000; Workington, 24,500; Maryport, Moss Bay, and Cleator Moor. The principal industries are **coal-mining** and **iron-smelting.**

Dublin, 317,000, the capital of the Irish Free State, has important **shipping** across the narrow seas, especially with Holyhead and Liverpool. It has manufactures of biscuits and other food products.

Belfast, 415,000, on Belfast Lough and the Lagan, has great **shipbuilding** yards and **engineering** works. It has also big rope and twine works and very important mills where linen goods are made. It is the capital of Northern Ireland.

Norwich, 126,000, an ancient city and the county town of

[1] Such compound towns are often spoken of as conurbations.

Norfolk, was for some centuries the most important centre of the British wool trade. It has to-day engineering works, the manufacture of waterproofs, the making of chocolates, and the production of starch and mustard.

Leicester, 239,000, is another ancient town that has become an important industrial centre. It has an important wool trade; and it has now some of the biggest **boot and shoe** factories in the world, which specialise in footwear for ladies principally. **Hosiery** is also made in large quantities. Leicester is a centre for the boot and shoe industry, which has many works in the counties of Northamptonshire and Warwickshire as well as in Leicestershire.

Northampton, 92,500, the county town of Northamptonshire, is an important centre for the manufacture of heavy boots and leggings.

APPENDIX I

ROCKS AND ROCK SYSTEMS

Rocks.—The rocks of which the earth's crust is made may be grouped into three classes.

A. *Sedimentary Rocks.*—These include those rocks which have been deposited or laid down, layer upon layer, by water or wind, on land or in lakes, estuaries and seas. They are usually stratified—that is, consist of layers or strata succeeding each other. They generally contain fossils—that is, the remains or traces of plants and animals.

The chief groups of sedimentary rocks are :—

1. Sands, sandstones, grits, conglomerates.
2. Clays, shales, slates.
3. Chalk, and other limestones.
4. Peat, lignite, coal.

B. *Igneous Rocks.*—These have solidified from the molten condition, either as great masses at some depth from the surface of the earth's crust, or after having been poured out as lava from the craters of volcanoes or from cracks in the crust. They are rarely stratified, and very seldom contain fossils.

Some of the best known igneous rocks are the following :—

1. Crystalline rocks which have become solid at some depth and under great pressure : granite, syenite, diorite, gabbro.
2. Rocks which have become solid after being poured out as lava : rhyolite, trachyte, andesite, basalt ; pumice ; pitchstone or volcanic glass.

C. *Metamorphic Rocks.*—These have been made by the complete alteration of sedimentary or igneous rocks, by long-continued pressure, heat, etc. They are so completely

changed that it is often very difficult to make out what they were originally.

The best-known types are: crystalline schists, gneisses, crystalline marbles, quartzites.

Rock Systems.—Rocks are classified according to their relative age, using the sedimentary rocks as the key; the other classes fall into the systems into which the sedimentary rocks are arranged. A working table of the systems is as follows:—

RECENT ROCKS.

Tertiary or Cainozoic Rocks		Pliocene Miocene Oligocene Eocene
Secondary or Mesozoic Rocks		Cretaceous Jurassic Triassic } New Red Sandstone
Palæozoic or Primary Rocks	Upper	Permian } New Red Sandstone Carboniferous Devonian, with Old Red Sandstone
	Lower	Silurian Ordovician Cambrian

PRE-CAMBRIAN AND ARCHÆAN.

APPENDIX II

QUESTIONS AND EXERCISES

Chapter I

1. Find out if the rainfall is measured in your town or school district. Compare the annual rainfall with those of East Anglia and the Scottish Highlands given in Chapter I. Compare also with any holiday places you are in the habit of visiting.
2. Why is much of the water available for London and district hard? What is meant by saying that water is hard? What is done to soften it?
3. What is meant by "the Rising in 1715"? Why did the Government of the time have roads made into the Highlands? A fine road was also made later across northern England from near Carlisle to near Newcastle. Why was this road made? What very famous historical relics existed along almost the same route?
4. Make a map of the route followed by the Leeds and Liverpool Canal. Why is a more direct route not used? What "branches" does that canal give off?
5. What groups of languages are spoken in Europe? Which of them have contributed largely to modern English? Do people speaking the same language necessarily belong to the same race? Give examples from Great Britain and Ireland, and, if you can, from the Continent of Europe.
6. State and explain the differences between the geography of the south-east and the north-west areas of Great Britain.

Chapter II

7. In which of the Physical or Structural Regions of Great Britain or Ireland do you live? What other structural regions have you visited?

8. Using a good atlas, find the names of as many peaks in Scotland as you can which are over 4000 feet high, and over 3000 feet high in England, Ireland, and Wales.
9. On an outline contoured map of Scotland colour or shade the areas bounded by the different contour lines. Notice how the contour colouring or contour shading brings out the build of Scotland.
10. Make a horizontal section from Carlisle to Fort William, using a vertical scale of 1 inch to 4000 feet, and a horizontal scale of 1 inch to 20 miles.
11. Five upland regions can be seen from the Isle of Man; arrange them in the order of their highest peaks. Name some peaks in each of the five groups of uplands.
12. Describe the structure and give some account of the scenery of the Highlands and the western islands of Scotland.

Chapter III

13. Shade or colour an outline contoured map of the North of England. Name the structural divisions thus brought out. Retain your map for later studies of railway and canal routes.
14. Copy figure 11. Then draw a similar section showing in addition an impermeable stratum on the top of the sandstone, the whole bent into a downfold or syncline. Reason out how a water supply could be obtained on the surface of the middle part of the trough thus shown.
15. Write down the titles of well-known poems and standard works of fiction which are associated with (*a*) the Highlands of Scotland, (*b*) the Lowlands of Scotland, (*c*) the Lake District, (*d*) the mountains of North Wales.
16. What natural lakes are used for water supply for towns and cities, and which other lakes are likely to be used in future for that purpose?
17. What rocks and minerals are obtained from the Pennines, the Welsh Hills and the Welsh Borders, and the south-western Peninsula?

18. Draw horizontal sections across northern England (*a*) from St Bees Head to Scarborough, (*b*) from Liverpool to Bridlington, (*c*) from Chester to Cleethorpes. Use the same scales as in question 10.

Chapter IV

19. It is claimed that Leamington is the central town of England. Using a good map and a ruler, see how far this claim seems to be justified.
20. What rivers flow outwards from the New Red Sandstone plain, and into what estuaries do they flow? How do you account for the fact that no rivers flow from that plain to the Thames estuary?
21. What do you know about the following:—the Dukeries, Sherwood Forest, the Vale of Taunton, the Vale of Crediton, the Vale of Pewsey, the Vale of Wardour, Stonehenge, the Broads?
22. What historical events have been associated with (*a*) the Fenlands of the Wash, (*b*) the Isle of Ely, (*c*) the Isle of Athelney, (*d*) the Isle of Axholme?
23. Describe and illustrate by a sketch-map the position of the chalk hills around the London Basin. Point out where the main lines of railway cross the chalk hills.
24. Describe and explain the structure of the Weald, and show how it is drained by rivers.

Chapter V

25. Find the six different structural regions of Ireland on the geological map, fig. 20, and write down what kinds of rocks are found in each of the six regions.
26. Name the regions in Great Britain which have the same rocks and which correspond in general character with the six regions of Ireland.
27. What are fiords, rias, and sounds? Give examples of each from Ireland.
28. Give as complete an account as you can of the formation of peat. Why is peat of great importance in Ireland? For what purposes is it used?

29. What rocks and minerals of economic value are obtained from Ireland? Mention the different regions from which those you name are obtained.
30. What do you know about Giant's Causeway, the South-Western Rias, the Golden Vale, the Gap of Killaloe, the Bog of Allen, the Vale of Limavady?

Chapters VI and VII

31. Draw simple but careful sketch maps of the Tay, the Forth, the Clyde, the Tweed. In each case show the position of the chief towns on their banks.
32. Make a sketch map of the Yorkshire Ouse system of rivers. Show the position of the important towns on the various tributaries. Underline the towns which stand where the Pennine feeders of the Ouse leave the hills to pass on to the north-eastern plain.
33. Why are there so many rivers in Great Britain called Avon, Calder, Dee, Derwent, Don, and Ouse? How many rivers of each name do you know, and where are they?
34. Draw a sketch map of the Mersey and its tributaries. Mark the position of the following towns:—Bacup, Rawtenstall, Haslingden, Bury, Bolton, Rochdale, Heywood, Middleton, Oldham, Mossley, Ashton-under-Lyne, Manchester, Salford, Eccles, Leigh, Stretford, Stalybridge, Dukinfield, Hyde, Stockport, Warrington, Widnes, Liverpool, Bootle, St Helens, Birkenhead, Wallasey.
35. On what rivers are the following towns:—Kendal, Grange, Ambleside, Ravenglass, Whitehaven, Cockermouth, Keswick, Penrith, Workington? Which of these towns would you regard as "Gates to Lakeland"?
36. Describe the courses of the rivers Witham, Welland, Nene, Great Ouse. Do these rivers form boundaries of counties or flow through the middle of counties? What county towns are situated on the banks of these rivers or their tributaries?
37. Make a sketch-map of the chief rivers that make up the Thames system and the uplands from which they flow. Show the position of the following towns:—

Banbury, Witney, Abingdon, Wallingford, Aylesbury, Marlborough, Newbury, Guildford, Dorking, Maidstone, Hertford, St Albans, Watford, Rickmansworth.

38. Of what counties does the Thames form part of the boundary? Compare the Thames with the Severn in respect of their relation to counties.
39. What English and Welsh counties are wholly or mainly drained by the Severn and its tributaries? Write the names of the county towns and the river on which each stands.
40. Draw a sketch map of the Shannon and its tributaries. Of what counties does the Shannon form part of the boundary?
41. Name the chief lakes of Ireland. Explain their position as fully as you can.
42. Find out as much as you can about any or all of the following:—the New River (East London), New Bedford River (North Cambridgeshire), the Humberhead Levees, Thames Conservancy.

Chapter VIII

43. What are the latitudes of the Scilly Isles and the Shetland Islands? How many *miles* are they apart? What would you regard as the average or mean latitude of Great Britain and Ireland? Name a well-known town in each of the countries, England, Scotland, Ireland, which is approximately in that latitude.
44. Write down the longitudes of Lowestoft Ness and Blasket Island. What is their distance apart (*a*) in degrees of longitude, (*b*) in *miles*, approximately?
45. Taking the 100-fathom line as the approximate limit of the Continental shelf, do any of the islands of Great Britain and Ireland lie outside that limit? To what class of islands, Continental or Oceanic, do they all belong?
46. Using an orographical map, classify the greater islands and island groups as mountainous or low-lying respectively. Which is the most mountainous group of all?
47. The Island of Staffa, the Scuir of Eigg, and Giant's Causeway show interesting and peculiar features.

What do you know of the nature and origin of those features ?

48. Where and what are the following :—Ailsa Craig, Bass Rock, the Old Man of Hoy, Seven Heads, the Wolf Rock, Portland Isle ?

Chapter IX

49. How do you think the Strait of Dover was formed ? Give your reasons as fully as possible.
50. What evidence have we, other than that of similarity of rocks, that Great Britain was formerly united to the Continent and Ireland to Great Britain ?
51. Where is the coast of England suffering from erosion very rapidly ? Where are considerable coastal gains taking place ?
52. Obtain a tide table for the port nearest to you. What are the intervals between successive high and low tides ? If possible compare the times of high and low tides with the times at other ports on the same coast.
53. Have you seen dredgers at work in any of our rivers or estuaries ? Find out what you can about the work of dredging. What becomes of the mud and sand which the dredgers bring up ?
54. Suppose gradual upheaval to the extent of 100 feet took place in our region, which islands would be joined to the " mainlands," and which would still remain islands ? Name one long group which would become a long island.

Chapter X

55. What is meant by a " rain-shadow " ? Give instances from Scotland, England, Wales, Ireland.
56. What do you notice about the direction of the winds in relation to the isobars in the map of a cyclone, fig. 50 ? Do the winds blow from high pressure towards low pressure directly or indirectly ? Imagine yourself standing with your back towards high pressure and your face towards low pressure, in which direction—to the right or to the left—are the winds deflected ? Try this at several points on the map.

57. Study the map of an anti-cyclone, fig. 51. What is the general relation between the isobars and the direction of the winds? Are the winds as strong generally in the anti-cyclonic as in the cyclonic system shown on fig. 50? Repeat the observation as given in question 56. Compare the results observed in the two systems.
58. What is an isotherm? How does the general direction of the isotherms over Great Britain and Ireland in winter differ from the general direction in summer? Explain as fully as you can.
59. Compare the average January and July temperatures of the following pairs of towns:—London and Londonderry, Harwich and Galway, Bournemouth and Oban, Colchester and Aberdeen, Hull and Liverpool.
60. In which parts of Great Britain and Ireland are found (*a*) the rainiest, (*b*) the driest, (*c*) the most equable, and (*d*) the most extreme climate?

Chapter XI

61. If you live in a large town find out where your milk, butter, and eggs come from, and also what districts supply you with potatoes and fresh vegetables. If you live in the country or in a small market-town find out what produce of the land is sent to the large towns, and by what means—road, canal, or railway.
62. What are the factors which enable wheat to be grown profitably in East Anglia? In what other regions is wheat grown in Great Britain or Ireland?
63. Which are the most successful dairy-farming districts of Great Britain? Why does Ireland produce large quantities of dairy produce? From which Irish ports is it sent out, and which ports in Great Britain receive most of it?
64. Where are potatoes, beetroot, hops, flax successfully grown in Great Britain and Ireland? What are the conditions which make the districts you mention suitable for the cultivation of these crops?
65. Why is Kent frequently called "The Garden of England"? Mention some of its most important productions.

66. Which are the principal sheep-rearing districts of the British Isles? What are the natural conditions which favour sheep-rearing in the districts you mention?

Chapter XII

67. What rocks are exposed in your district? Are any of them quarried, and, if so, for what purpose? If any of them are sent away for some distance find out by inquiry the places to which they are sent.
68. Of what material are your houses and school built? Where have the materials come from? What kinds of ornamental stones can you see in your town? Of what materials are your streets paved?
69. Where does your domestic coal come from? Is any anthracite used for stoves in your school or your home, or in any shops or offices you know? Where does the anthracite come from?
70. What holiday resorts have you visited? What rocks are exposed there? Do they form high cliffs, or rock pools, or sunken reefs, or skerries?
71. With what materials are the buildings in your district roofed? What has determined the use of the materials you mention? Have different materials been used at different times? If so, why?
72. What do you think about the statement, "The attraction of the towns is really the attraction of minerals"?

Chapter XIII

73. How is coal-tar obtained? What two sources furnish large quantities? What substances used in everyday life are obtained from tar?
74. Where is salt found in considerable quantities in Great Britain and Ireland? How is it obtained? What industries are directly dependent upon salt?
75. Find out the locality of the nearest chemical works to your home or school (it may be at a considerable distance). What materials are made there? Where do the raw materials come from, and where are the finished products sold and used?

76. Try to find out where the soap used in your school and home is made. Do the same with the boot polish, stove polish, dry soap, and any other "chemicals" used in your home. (Consult the chemistry teacher in your school if you are in difficulties.)
77. Which ports are likely to import cotton-seed oil from the United States, beef tallow from Argentina, mutton tallow from New Zealand, beef and mutton tallow from Australia, palm oil from West Africa? In what industries are these materials used in large quantities?
78. Why are so many chemical works situated on or near coal-fields? On the other hand, why are there so many in east and south-east London?

Chapter XIV

79. Make a list of the metal goods in your home, and write opposite the name of each the place where it was manufactured, so far as you can find out.
80. From what regions in Great Britain and Ireland are iron ores obtained? Which regions are most important? From what other parts of the world do we import iron ores?
81. What materials are necessary for iron-smelting? Give instances where the ore is carried to the other materials, and instances where the ore is smelted in the region where it is mined or quarried.
82. In many schools some pupils come by train. Ascertain where the railway engines and coaches by means of which they travel are built. Do the same with any tram-cars used by yourself or your fellow-pupils.
83. If you look at a population map of England you will see that South Staffordshire and a portion of South Wales are very densely peopled. What industries give employment to the people in those districts? What reasons can you see for the importance of the particular industries in those districts?
84. What engineering works do you know in your own town or district? What kinds of machines or engines are produced there? Where are the raw materials obtained?

Chapters XV and XVI

85. In what parts of Great Britain and Ireland are important wool industries located? Compare with the distribution of wool industries two hundred years ago, and account for any changes.
86. Omitting the cotton industry, give an account of the distribution of the textile industries in Scotland and Ireland, and account for that distribution.
87. Give two reasons why the great cotton industry of Lancashire and neighbourhood is so dependent on shipping facilities.
88. Where are silk manufactures carried on in Great Britain or Ireland? Can you give any reasons why this industry is so scattered?
89. During the Middle Ages Great Britain was chiefly an agricultural country. What were the exports then? When did the great change come which made Great Britain and Ireland the leading manufacturing region of the world? What effect did this change have upon the imports of the country?
90. Find out the population of your county, and its area in square miles. What is the population per square mile? Compare with other counties quite differently situated.

Chapters XVII and XVIII

91. What railway or railways serve your town and district? If it is not a large town find out the destination of all the trains which pass through or start from your town on an ordinary day.
92. If there is a canal in your district find out with what places it is connected, and what goods are regularly carried on it.
93. Make a map of the *chief* roads, canals, and railways of your district. (It may be well to make two maps: (*a*) the district within a radius of ten miles of your school, (*b*) the district within fifty miles of your school. Consult your teacher.)
94. You may read in the newspapers of "a through train from Aberdeen to Penzance." Work out a feasible

route, making it reasonably short, and indicate what railway companies' lines will be used.

95. Why are there more railways across the Southern Pennines than the Northern Pennines? Prove that this is so by reference to a railway map.

96. Work out a route for a through train from Liverpool to Newcastle, making it pass through a number of important towns. Compare your route with that actually followed by trains from Exchange Station, Liverpool, to Newcastle.

97. What do you consider to be the chief requirements for a commercial seaport?

98. Take examples from Great Britain and Ireland and show the relationships existing between manufactures, mineral resources, and transport routes.

99. Express trains are run on three main lines of railway between London and Manchester. What companies run these trains? What are the routes which are followed, and between what termini at London and Manchester do the trains run?

Chapter XIX

100. State some of the factors which have helped to make London the greatest port and the greatest city in the British Commonwealth.

101. Why are food products among the chief manufactures of London? In what parts of London are they largely made? Name some of the most important.

102. A. *For Schools not in London District.*—(*a*) Work out the route followed by the most convenient train service between your town and London; (*b*) work out a route for a cycle or motor run to London, passing through some places famous in history.

B. *For London Schools.*—What railway or other routes would you use to travel to the following holiday resorts:—Oban, Inverness, Portrush, Killarney, Keswick, Newquay (Cornwall), Scarborough, Barmouth?

103. By what route could goods be carried from Manchester to London by canal? Do you know of some difficulties that would have to be overcome?

104. From which of the London termini would you start for the following :—the Norfolk Broads, the Lake District, the Lakes of Killarney, the Derbyshire Dales, the Dales of north-west Yorkshire, Scarborough, Penzance, the Isle of Wight ?
105. Which London termini deal with the mails for Scotland, Northern Ireland, Southern Ireland, Holland, France ?

Chapter XX

106. Compare the industries of the Central Lowlands of Scotland with those of the Central Plain of Ireland. Explain any differences which you mention.
107. What are the chief industries of :—East Anglia, Cornwall, Lincolnshire, Cumberland, the Hebrides, South-East Ireland ?
108. Draw separate maps of (*a*) the busy industrial regions, (*b*) the coal-fields of Great Britain. Compare them. In what respects do they differ, and why ?
109. Compare a population map of the present day with one of two hundred years ago. What are the chief differences ? Explain as fully as you can.
110. Compare the population of Hampshire with that of Lancashire, in total number of people, and in density of population. Was it always so ? Explain the present differences compared with the past.
111. What cities of Great Britain and Ireland contain more than a quarter of a million people ? What proportion of these are on coal-fields ?

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